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Engineering News-Record

Devoted to Civil Engineering and Contracting
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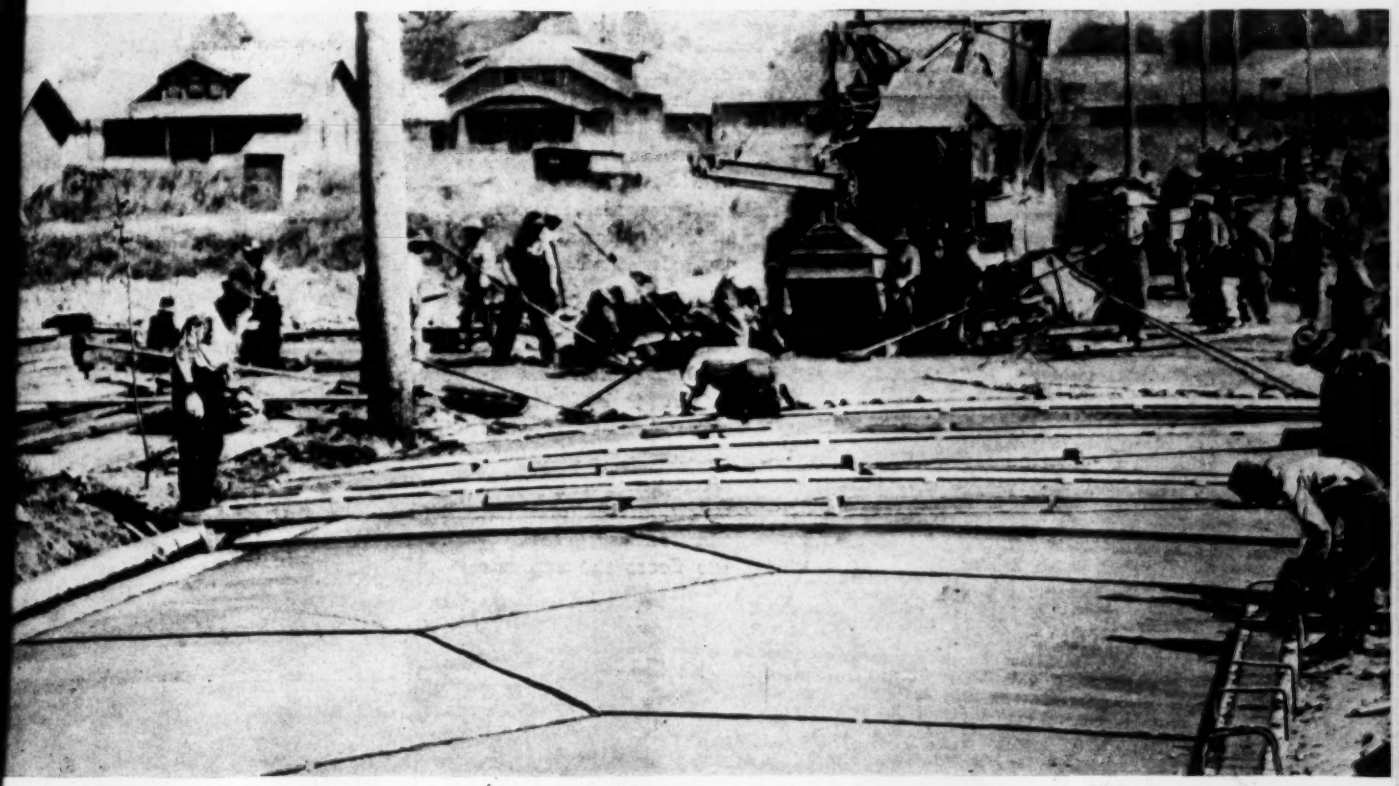

Concrete Road of Hexagonal Slabs in a New Western Town

Hexagonal Slab Concrete Pavement at Longview, Washington

Survey Control in Driving 3-Mile Water Supply Tunnel

The Editor Visits the City Engineer of Rockford, Ill.

Coastal Highway Crossing of Savannah River Delta

Also: Several Pages of "Job and Office" Hints

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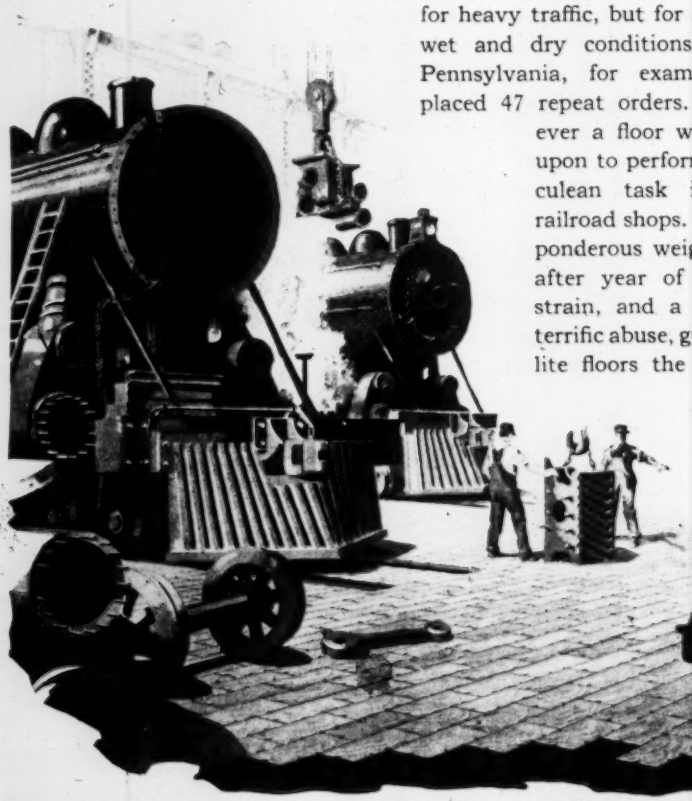

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 95 NEW YORK, OCTOBER 8, 1925 Number 15

Draining the Government Service

ANOTHER of the leaders in government technical research has left for more lucrative private employment. One by one the service is depleted, because of the government's parsimonious policy. Government technical service has its attractions, as no one knows better than these gentlemen who are leaving it, but a man has some obligations to his family, that they shall be decently clothed and fed and mentally and spiritually enriched up to the station in life that their desire entitles them. And by no possible chance can a government engineer or scientist today satisfy those obligations from his salary alone. Possibly it is cheaper to train men to the point where they begin to be real experts and then let them go, only to start to train new men, but private business has never found it so. The budget system is supposed to supply the advantages of business experience to government. Why cannot the federal budgeters take this lesson to heart?

Hexagonal Pavement

A HIGHLY interesting variation in concrete paving practice has been adopted at Longview, Wash., as described in this issue. The pavement slab is divided by joints into hexagonal sections to eliminate as far as possible the square angles of rectangular subdivision and substitute the stronger obtuse angles of the polygon. The idea also is to minimize the occurrence of accidental cracks which may produce acute corners, by reducing continuous slab areas. Theory and tests have been worked out in considerable detail, as the article discloses. The surprising fact presented, however, is that the construction of this multi-jointed pavement is asserted to be costing no more than the standard structure with a center joint and the usual transverse separations for expansion. This, of course, is the designer's assertion, but the facts he presents give it strong support. In brief, there is nothing in the new design which precludes the use of any of the usual and standard concrete roadbuilding equipment or tools. The construction is yet too young in service to give records of endurance and stability under traffic. It can be classed as yet only as an interesting experiment.

New Matter on Shore Protection

ATTENTION is called to the abstract of the report on coast erosion and protection made by the New Jersey Board of Commerce and Navigation and abstracted on p. 598 of this issue. There are, obviously, only a few of our states in which this problem arises but where there is an ocean beach the difficulties of its protection are very great. New Jersey has a large interest in such a study because practically the whole of its long ocean front is developed as the playground of the metropolitan east and no small part of the state prosperity hinges on the stability of those shores. For years, therefore, the state has been studying the phenomenon of shore erosion with more completeness and scientific attention to detail than anywhere else in this country or possibly in the world. The latest report gives the current status of the conclusions of the state's experts. No one concerned with shore erosion should proceed to protective measures before studying what the New Jersey engineers have prepared as a result of their long experience. This advice is particularly applicable to the developers of Florida where physical conditions are so similar to those in New Jersey and where millions of dollars are being spent reclaiming and protecting shores that only months ago were barren wastes untouched by the magic wand of the real estate boomer.

Non-Federal Roads

FEDERAL-AID roads have been so emphasized that engineers, and much less citizens in general, do not always realize that road construction outside of roads which receive help from federal appropriations is a mighty task. The records are interesting. To Jan. 1, 1925, federal funds had contributed to the construction of 58,948 miles of highway, of which 12,462 miles were then under construction. In the same period and of roads of the same class, states and counties, without federal aid, had completed or had under construction 62,931 miles. And all the money going meanwhile to maintenance came from state, county and township funds. No federal-aid money forms any part of highway maintenance expenditures. From these figures it is obvious enough that states are not being forced into road improvement by the requirement to match federal-aid allotments. The public does not require temptation to spend money for highways, and in any case Henry Ford has been a far more powerful tempter than federal aid.

Railway Sanitary Engineers

ANNOUNCEMENT by the Rock Island Lines that there has been appointed as consulting sanitary engineer a man who has for some years past been sanitary engineer for the St. Louis Southwestern Ry. suggests the question, how many of our railway systems have sanitary engineers and of those who do not, how many might do so to advantage? The work on these two lines is called for largely by regional conditions, this work being malaria control. Other parts of the country than those reached by these two railway systems have need of malaria control work and on all our railways there is constant need for the improvement of the environment of railway employees by eliminating insanitary conditions on the railway lines and in the towns where their employees live, especially in small towns. Besides this, every railway engaged in interstate commerce has to give careful attention to

the drinking water supplies on its trains in order to comply with the so-called Treasury Standards administered by the United States Public Health Service. Doubtless on many lines the last mentioned matter is well handled by the railway water supply departments, but not all the men in charge of these departments are well versed in matters of sanitary engineering. It is gratifying to see that some of the railways of the country are appointing sanitary engineers to look after problems which can be best handled by members of that branch of the engineering profession.

Road Research Reviews

HIGHWAY research data have attained so great a volume and are so widely scattered among the professional papers and technical reports of a decade that practicing road builders have for some time felt the need of a review and summary practicable for consultation and daily use. The task has now been undertaken by the experts of the Bureau of Public Roads. The first review is of subgrade studies, not alone the studies of the bureau engineers, but all studies having any bearing on road construction, which have been made in the last ten years. As printed in the bureau organ, *Public Roads*, the review is about equivalent in volume to a 100-page book of ordinary page and type size. It is complete with a bibliography so that the student can readily range into the detail of original sources as he may require. Further summary here is out of place even were it practicable in the space, but the highway engineer should secure the October copy of *Public Roads* and also keep in mind that similar compendious reviews are to follow on the subjects of design and construction of road surfaces, the economics of highway transportation, finance and administration, and other lines of investigation.

Worth-While Co-operation

A PROMISING co-operative effort was initiated last week by a meeting of steel fabricators and structural engineers at New York to discuss unsatisfactory methods of preparing plans and calling for bids. In the question particularly before the meeting, the two parties—engineer and fabricator—at first sight appear to be business antagonists; but in actual fact their aims are identical. It is to the interest of both to have clear and full plans prepared before bidding, and to bring about well informed, truly competitive bidding. Certain conditions for which neither party is responsible have led to the practice of calling for pound-price bids on plans so incomplete or sketchy that they often mislead, and in consequence tend to bring about unsound bidding. The resulting loss usually falls on the contractor, but in the long run the customers of the industry pay the loss. At the time of bidding the successful bidder is likely to take an optimistic view of probable changes in plans and their effect on the cost of the work while on the other hand the engineer, when once he has received and accept a contract price per pound, will inevitably tend toward detailing his sketch plans in such a way as to save weight even though the workmanship is made more costly in the process. Nevertheless, both parties recognize clearly that such bidding is unsound, and in turn tends to make the entire business unsound. Its ultimate effect is to encourage hasty and slipshod work and furnish an incentive to sharp practice. The discussion at the meeting referred to confirmed the fact that the two parties have a joint interest in improving this condition. The difficult part of the task is to define, if possible, the desired degree of completeness of bidding plans, and this problem obviously requires the co-operation of engineer and contractor. When this first item of joint work is accomplished, however, the two parties may find that there are various other problems in need of their co-operative efforts. Their interests are identical in more than one respect. Perhaps this relation will prove to be a basis for a permanent commercial association or board of engineers and contractors. Even some purely professional questions of structural engineering could be brought nearer their solution with the aid of such a form of organization. And almost the same remark might be applied, we believe, to other fields of the engineer's and the contractor's activities than that of structural steel.

Some Ethical Cases for Consideration

TO MOST engineers codes of professional ethics are academic affairs until some particular violation of such a code becomes a personal matter. In which, the engineer differs not at all from the rest of humanity in its relation to all codes of conduct. Nevertheless, society for its own protection has codified, crudely to be sure, the principles of ethics and morals into law and has set up the machinery to enforce such law. Professional conduct, especially in the engineering profession, still remains a matter of individual interpretation and individual desire to conform to a group conscience. It is perhaps debatable whether or not professional obligations can be imposed on the individual, but it is a fact that so far the major engineering professional societies have considered the difficulties of such enforcement so great as to lead them practically entirely to evade any responsibilities that they might have in such enforcement. And such evasion, it is possible, has led to a current impression in engineering circles that ethical codes are not widely violated by reputable members of the profession, or at least that the restrictions under the code are so few that many acts can be committed which, to revert to the first sentence of this paragraph, become of interest to the individual only when he is in his own opinion an injured party.

It may be informative, therefore, to set down here four instances of charged violation of proper professional practice that have, within the month, been brought to the attention of this journal. These cases are recited, in as unbiased manner as possible, without relation to individual or location and without prejudice as to the rights or equities involved, merely to show to the profession that daily there are arising instances of, to put the best possible face on it, misinterpretation of individual duty in the practice of engineering, and to raise the question whether it may not be time for the profession to set up some sort of court wherein may be built up a body of ethical law.

In case 1, the low bidder on a recent large city construction contract was an unknown corporation which turned out to consist of a bond salesman, a lawyer and an engineer who had not been in practice for about a year. This company had a nominal capital of $2,000, although the bid for the contract was over $1,000,000. On investigation it appeared that one of

the financial backers of the company, a financially responsible individual, was the brother-in-law of one of the principal engineers in the city department which designed the structure in question, wrote the specifications and would supervise its construction. The next highest bidder immediately brought charges before the awarding board that the new firm had been assisted in the preparation of its bid by this engineer in the city service and his superior and charged further that these two engineers had been in early possession of information regarding the estimates and had, as engineers for the city, discussed with some of the other bidders the early details of their bids. Without public examination of these charges the two engineers resigned their positions. The superior officer in the city department states that there could have been no advantage taken by these two engineers in making up the figures for the bids, as both the plans and specifications were completed and checked by the superior officer and were in the hands of the printer before the two engineers could have entertained the idea of making up figures for any bidder. It is not denied, however, that these two engineers did assist in the bidding nor that it was their intention if the company secured the contract to leave the city service and to take charge of the prosecution of the work for the company. The awarding body finally threw out the low bid of the questioned company on the ground that it was not a responsible bidder and awarded the contract, at an increase of $75,000 over the low bid thrown out, to the second bidder. Both engineers involved are members of the American Society of Civil Engineers and have always stood very high among their fellow engineers as well as in the community. They have a long and favorable record in the city department.

In case 2, a state public service commission ordered a certain grade-crossing elimination and allocated the cost between the railroad, the state, the county, the township and the borough. It also ordered the work to be performed under the direction of the county authorities. A certain engineering company was employed to prepare plans and specifications for the work. There are charges made that there was not the legal amount of preliminary time of advertisement for bids on the plans and specifications so prepared and also charges that some concerns interested in bidding on the work were unable to secure plans within a reasonable time after request was made for them. In any event, bids were opened and the award of contract for construction was made to the same company which acted as engineers for the county and prepared the plans and specifications for the construction of the work, this company having put in the low bid as contractor. It is charged, furthermore, that an officer of that company, a member of the American Society of Civil Engineers, is to be retained as consulting engineer during construction of the work.

In case 3, a firm of architects who were registered to practice professional engineering and land surveying in a certain state, prepared plans and specifications for a public building on which bids were subsequently asked. In these plans and specifications there was included a type of concrete reinforcement so described and so drawn, according to the charges, as to make it difficult, if not impossible, for the manufacturer of any other type of reinforcement to submit bids or to make prices. At any rate this particular reinforcement was bought by the successful contractor. It is further charged that the company manufacturing this reinforcement is controlled by, or at least has as officers, the two members of the firm of architects making the plans and specifications. Charges were brought before the State Registration Board which, after preliminary investigation, held that they were neither "trivial nor unfounded," which is a provision of the law in that state preliminary to a full investigation, and ordered a complete investigation of the charges at a hearing soon to be held.

The fourth and final case involves a charge of professional competition on a fee basis. In a certain city, a revision of the water-supply system has been under consideration for some time. One engineer for some years has been under engagement to study the proposition, as a result of which he made a preliminary report recommending improvements estimated to cost $1,200,000. Following that estimate, the water-works engineer of the city took under consideration the selection of an engineer to carry out the work and asked a certain number of engineers to come to the city, interview the local officials and go over the work. Subsequent to this being done, this city engineer made inspection trips of works built by the various engineers under consideration and finally asked them to submit proposals on the cost of doing the work. These proposals were made on both a percentage and a lump-sum basis. It was found that the five engineers presented proposals varying from 5 to 7½ per cent in the percentage column, and from $60,000 to $90,000 in the lump-sum column, the low percentage bidder of 5 per cent being the low lump-sum of $60,000, indicating an estimate on a total of $1,200,000. One of the 6 per cent bidders was the engineer who had made the original plan and who bid 6 per cent or a total of $90,000, that being on the basis of a total cost of $1,500,000 because, as explained by this engineer, the city engineer had indicated that an additional $250,000 was to be added to the work in a change of plan from that made in the original design.

The city soon announced that the work had been awarded to the low bidder for his lump bid of $60,000, the water-works engineer announcing at the same time that the final decision on the appointment had been made after inspection of works built by the various engineers and intimating, at least, that the selection had been made on the basis of professional excellence and not of cost. However, there is in evidence a letter from the city manager of the city to a complaining engineer which asserts, first, that the engineers selected were in possession of the knowledge that the total cost of the work was to be $1,500,000 or more and furthermore that the award was made because the city "had a proposal of a satisfactory nature from a reputable firm of engineers which was much cheaper than that submitted by you." It should be said that there is no question here regarding the professional capacity of any of the engineers involved.

These are the cases. Because full investigation of each is not possible without resort to subpoena or similar machinery, assurance cannot be made of the exact facts, and for that reason no one of the cases is tied down to an identification. Indictment of individuals and exposition of principles are not the purpose of this comment. It is offered to indicate to engineers that there are curious and shady bypaths in the practice of engineering, the illumination of which would seem to be a professional obligation.

Hexagonal Slab Concrete Paving at Longview, Wash.

Design, Theory, Laboratory Tests and Actual Construction Experience With New Type of Concrete Pavement

BY L. A. PERRY
Construction Engineer, Longview Co., Longview, Wash.

Nearly 400,000 sq.yd. of concrete pavement jointed so as to form hexagonal slabs, have been put under construction in 1924-5 by the city of Longview, Wash., an industrial town now two years old. Theoretically a stronger design and a pavement as easy and as cheap to construct are asserted to have been secured. Greater strength is predicated on both theory of slab strength and upon comparative tests on small hexagonal and square slabs. Equal ease and cost of construction is proved by construction operations extending through two years. The records of study and experience are an interesting contribution to paving practice.—EDITOR.

EXPERIENCE shows the common failure of concrete pavement to be corner breakage and succeeding progressive destruction. Corner weakness it is known also increases as the corner becomes acute. The rectangular slab corner is less strong than one which is flatter or more obtuse. Stress analyses support these observed facts. To meet these weaknesses recent design has turned strongly to a doweled longitudinal center joint, to doweled transverse joints, to increased thickness at the edges and to marginal dowel bars. Proceeding on the theory that it is incorrect to compensate a pronounced weakness in design, when that weakness may be eliminated, the writer in planning the paving for the new city of Longview, sought a solution of corner weakness by arranging a plurality of hexagonal or fractional hexagonal slabs whose interior corners are substantially 120 deg., and whose 90-deg. corners at pavement edges were strengthened by increased slab depth. The arrangement is illustrated by

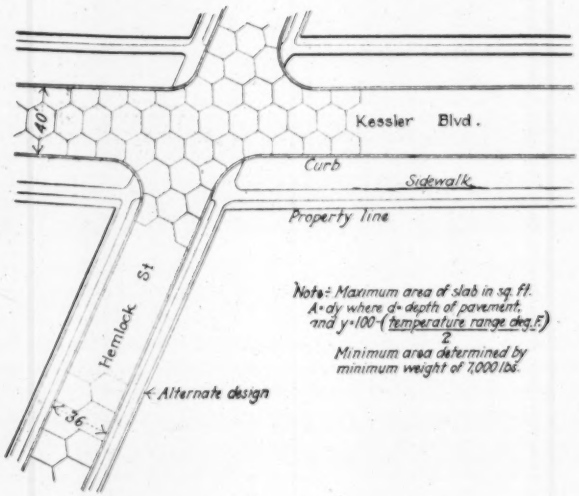

40
Kessler Blvd.
Curb
Sidewalk
Property line
Hemlock St.
Note: Maximum area of slab in sq. ft.
A = dy where d = depth of pavement,
and y = 100 - (temperature range deg. F.) / 2
Minimum area determined by minimum weight of 7,000 lbs.
Alternate design
36

FIG. 1—ARRANGEMENT OF HEXAGONAL SLAB PAVEMENT

Figs. 1 and 2. Discussion of this design is contained in a paper before the American Society of Civil Engineers, to be published in an early issue of the *Proceedings* and it will not be extended here.

Slab Tests—In a study of comparative strengths two series of square and of hexagonal slabs were tested.

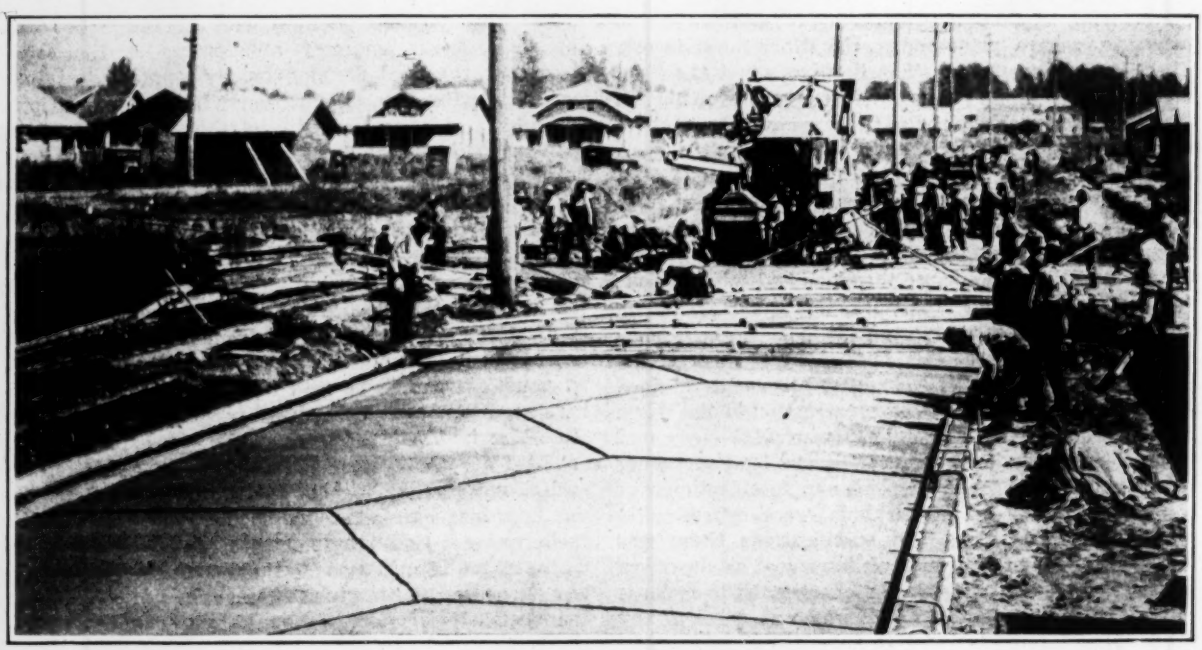


FIG. 2—HEXAGONAL SLAB PAVEMENT UNDER CONSTRUCTION

Showing construction of 24-ft. pavement. Note combined curb and gutter on one side necessitating edge deepening to compensate right-angled corners of adjacent slab. Corners on opposite side are protected by integral curb construction.

In the first series of tests, reported in the paper referred to, from eight to eleven slabs 144 sq.in. and 1:3 mortar, 4 in. thick of each shape were tested at 7 days and at

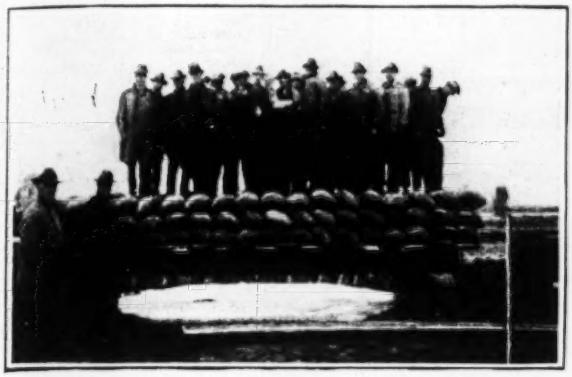


FIG. 3—METHOD OF TESTING LARGE SLABS
This shows test of Slab 3 of Fig. 4, a hexagon slab 5 in. thick under a loading of about 15 tons without failure.

5 months age. Calling the strength of the square slabs in each case 100 the hexagonal slabs showed 145 for 7 days and 167 for 5 months. The second series of tests not previously reported, were made as shown by Fig. 3 on large slabs (166.32 sq.ft. area) in April, 1925, and the results are charted by Fig. 4. Interpreting the results of these tests in the light of actual pavement design, it is found that the 5-in. hexagonal slab bore 8.6 tons at failure whereas a 4-cu.yd. truck load of gravel can rarely, if ever, create a wheel load of more than 3½ tons.

The question of frequency of traffic, within reasonable limits, has no bearing on the formation of initial failure; it does, however, constitute a direct measure of the life of a slab (which due to a subgrade fault may suffer a short corner break) after the initial failure

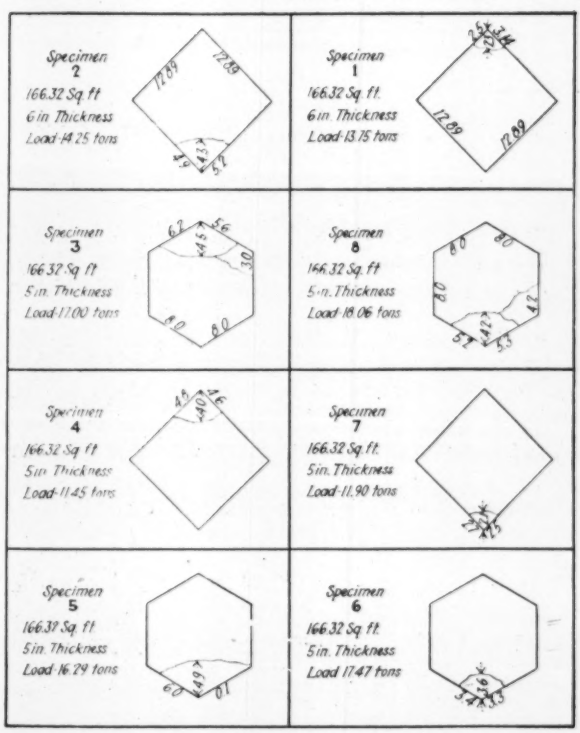


FIG. 4—CHART OF SLAB TEST RESULTS

occurs, since the frequent applications of wheel loads hastens progressive destruction of the initial failure. For this reason it is not advocated that pavement 5 in. thick, even of the hexagonal slab design, be used anywhere except on secondary residential streets, and then only under favorable subgrade and climatic conditions.

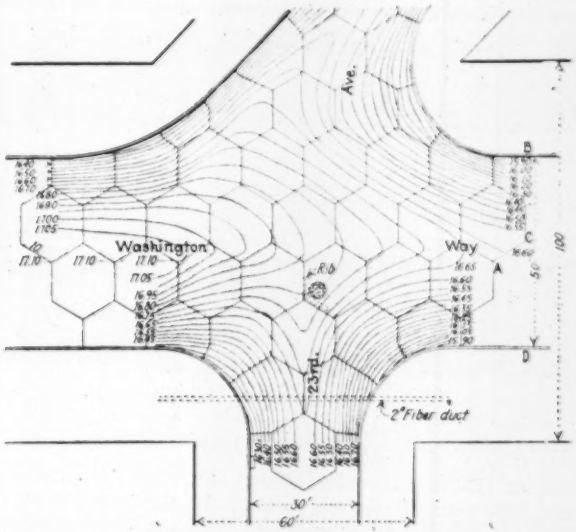


FIG. 5—METHOD OF DESIGNING INTERSECTION

Street Planning—As is generally the case in a new town development like Longview, a complete design of storm-sewer system for the area to be improved formed the basis for planning street improvements. It followed that the location and elevations of storm-sewer inlets fixed the street grades within allowable gutter gradients. Actual street grades were then fixed, giving consideration to correct crowns for varying widths of streets.

All intersections were made a subject of detailed planning. All elevations acting as control points, such as inlets and center line crowns at the points of curve returns, fixed the extremities of parabolic curves which are co-extensions of the radial lines. Then from fixed elevations in random locations all over the intersections

FIG. 6—SUBMERGED JOINT GIVES UNRESTRICTED USE OF FINISHING TOOLS

contour lines were carefully interpolated and fixed. Following these details a panel layout was made of the intersection. This was done by first choosing the "through" street, or the street considered principal, through which the panel scheme would carry without breach of continuity. All necessary irregular panels

TABLE I—CREW AND OUTPUT, AUG. 15, 1925

(Roadway 24 ft.; 2-panel; no moves; 21E paver)

Working Crew

Crew	Hours	Crew	Hours
1 Foreman	9	2 Finishers	18
1 Mixerman	9	1 Finishers' helper	9
2 Joint setters	18	1 Truck dumper	9
2 Rodders	18	2 Cement men	18
3 Spreaders	27	1 Utility man	9
1 Form setter	9	2 Laborers	18
1 Rollerman	9	1 Water boy	9
2 Limberfloaters	18		
		Total hours	207

Quantities

5 pavement land, sq.yd.	2,187
Extra concrete, cu.yd.	13.4
Cement, bbl.	507
Sand, cu.yd.	150
Gravel, cu.yd.	244
Expansion joint, lin.ft.	1,870
Water, flat rate	$14.41

TABLE II—CREW AND OUTPUT ON AUG. 4, 1925

(36-ft. roadway; 3-panels; two moves; 21E paver)

Working Crew

Crew	Hours	Crew	Hours
1 Foreman	9	2 Finishers' helpers	18
1 Mixerman	9	1 Truck dumper	9
2 Joint setters	18	2 Cement men	18
2 Rodders	18	1 Utility man	9
3 Spreaders	27	1 Sack binder	9
1 Rollerman	9	1 Laborer	9
2 Limberfloaters	18	1 Water boy	9
2 Finishers	18		
		Total time	207

Quantities

6-in. pavement, sq.yd.	851
5-in. pavement, sq.yd.	1,029
Extra concrete, cu.yd.	10.7
Cement, bbl.	464
Sand, cu.yd.	137.2
Gravel, cu.yd.	257.2
Expansion joint, lin.ft.	1,772
Water flat rate	$14.09

were worked out in the incoming streets. In Fig. 5 Washington Way is the through street.

Frequently, as shown in Fig. 5, manholes or other castings occur on the surface in points unfavorable to the slab structure, in which event the section reduction is compensated by a rib or deepening which is paid for as extra concrete. Where irregular slabs necessarily occur, prime importance is attached to the angles of corners, making them as nearly as possible uniform and of the greatest possible angular measure. Where section reductions, as in corner slabs in Fig. 5, occur, this section, if seriously reduced is compensated with a rib of extra concrete centered on the reduction and normal to the line of probable fracture. Such ribs are used where the reduced section is less than 40 per cent of the greatest dimension.

Construction Methods—Standard equipment and procedure as shown by Figs. 2, 6, 7 and 8 were used in construction. In general the construction of a pavement of this design is typical of any design involving a plurality of sections of uniform size and shape, excepting streets of a width too great for full pavement in one single operation. In this case templets or rods must be constructed in such a way as permits overlapping of a previously laid portion of the pavement. This is illustrated in Fig. 5. The standard templet used on Washington Way extends from *A* to *B*, and when used on the opposite side of the street, from *C* to *D*, the zone *A* to *C*

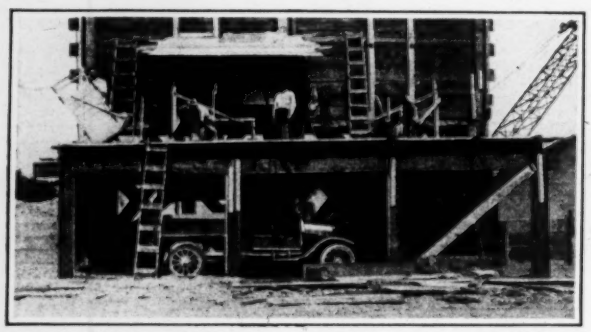


FIG. 7—EXAMPLE OF CENTRAL PROPORTIONING PLANT

Note rocker gravel screen in operation. The large white print on wall is an enlargement of Fig. 7, Bulletin 1, Lewis Institute, Chicago, with which mix adjustments for faulty grading are made.

representing the overlap. Intersections are "wiggle-tailed" (kneaded by heavy hand floats). A grade point is set at all slab corners and at each slab center. Having the entire intersection contoured makes it convenient to determine any intermediate elevation without delay to the mixer crew.

FIG. 8—TWO-STRIP CONSTRUCTION OF FOUR-PANEL ST.

Showing second operation on a 50-ft. street. Note overlap zone as shown in Fig. 5. This is being recovered with dirt immediately following the finishers.

All aggregates were shipped in gondola cars and handled by clamshells to central proportioning plants, Fig. 7. This handling involved stock piles in which a more or less serious segregation of coarse aggregate occurred at times. Mixtures were adjusted for this faulty grading by the Abrams fineness modulus. Bulk tests of sand were made at 30-minute intervals, and

TABLE III—CONCRETE LAID DAILY FOR TWO TYPICAL WEEKS BY TWO PAVERS

Date August	6-in. Pavement Sq.Yd.	5-in. Pavement Squ.Yd.	Extra Concrete Cu.Yd.
		Paver 2	
12	....	1,433	9.9
13	....	1,798	11.8
14	....	2,104	14.1
15	....	2,187	13.4
17	285	1,694	12.2
18	1,790	....	7.7
		Paver 3	
3	760	1,027	15.0
4	851	1,029	15.0
5	359	396	15.6
6	517	292	16.0
7	910	944	12.5
8	464	1,144	14.6

oftener when changes of supply occurred, and proportions were adjusted when serious variations occurred. Normal bulk was taken at 12 per cent. Slump tests

TABLE IV—BIDDING PRICES ON HEXAGONAL SLAB PAVEMENT IN 1925

Improvement District	6-in. Pavement Sq.Yd.	Unit Price	5-in. Pavement Sq.Yd.	Unit Price
1	83,328	$2.35	41,533	$2.05
2	57,259	2.20	13,156	2.00
3	20,000	2.20	Nil	....
4	51,399	2.27	Nil	....
5	26,129	2.20	9,391	2.00
6	9,058	2.17	Nil	....
8	4,000	2.15	Nil	....
9	Nil	....	1,600	....
10	3,200	2.05	Nil	....

were made at 30-minute intervals through the day for the purpose of water control. Under normal conditions a sieve analysis of coarse aggregate was made at 15-minute intervals, but when materials were erratic this analysis was made more frequently. Truck drivers carried a carbon copy of the analysis chart to field inspectors who noted thereon the slump and cement yield and immediately returned the chart to the bunker inspector who became a collection agency for these data. A laboratory for conducting physical tests of cement was maintained.

Progress and Costs—While this slab design may be thought more costly to construct by reason of its apparent elaboration, the fact is that there is no additional

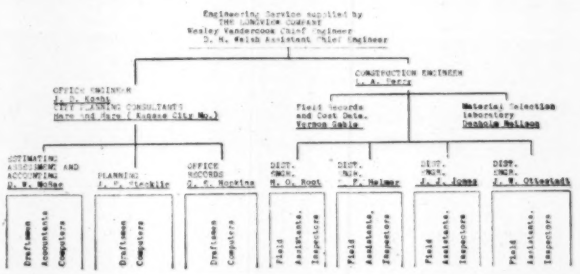


FIG. 9—ENGINEERING ORGANIZATION FOR PAVING WORK

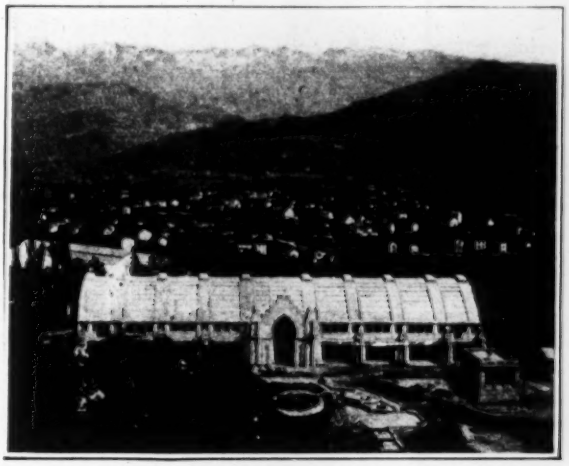
cost compared with a four-sided slab design of equal slab area.

Observations and cost analysis during the past two seasons indicate that better progress is consistently made than with the standard design. This is probably due to the fact that the nature of the design requires a well organized crew and that the value of this organization is reflected in progress. The chart, Fig. 9, is interesting as showing an organization for the engineering planning and construction *de novo* of an industrial city provided with all modern improvements and public services.

Tables I and II are copies of progress reports of pavers 2 and 3, on Aug. 4 and 15. They also show the mixer crew and materials used. It may be worthy of note that neither of these tables reports the record day's progress of the season. The two weeks reported are representative of the season's work (eliminating bad weather and periods of unusual delays). Table III shows a week's progress of each of these machines, of which the labor costs as shown in Tables I and II are representative. Table IV is a tabulation of contract awards for this work, for the year 1925 as of Sept. 1, showing the unit prices bid on 5-in. and 6-in. concrete pavement.

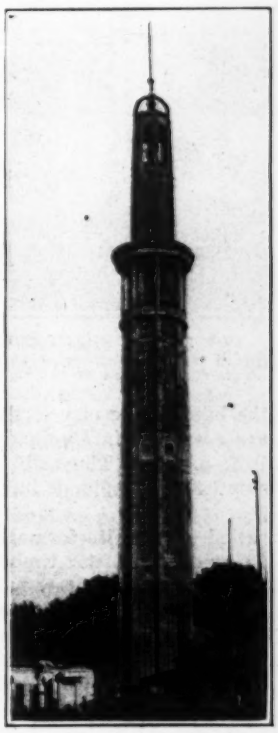
Grenoble "White Coal" Exposition Uses Concrete Construction

CONCRETE construction for all buildings, in contrast to the conventional exposition architecture using lath and staff, was used at the White Coal (Water Power) Exposition at Grenoble, France. The



HYDRAULIC POWER BUILDING

most conspicuous structure of the exposition was the 262-ft. observation tower finished in the natural color of the cement used. The foundations were extended down an additional 50 ft. below the ground surface. The tower contained an observation gallery surrounded by a steel lightning arrester just below the summit. Two elevators ran to the gallery, upon which was built an orientation table pointing out the surrounding mountains extending to the east as far as Mont Blanc. Of the principal structures, that devoted to hydraulic power was the most imposing. Color wash was largely used on the buildings, but the general aspect was of a white city.



OBSERVATION TOWER

The best and most complete exhibit was that of Germany's hydro-electric industries. Italy and Norway had extensive exhibits along similar lines. Interesting exhibits were shown in the tourists' section, which dealt largely with the application of electricity to transportation.

The display of electricity seen at night has not been excelled in any previous exposition in France. Notable among the lighting effects was the observation tower, which was illuminated by 3,000 electric lights.

Timber Cribs Floated to Place for Bridge Piers

Foundation Work on Burnside Bridge at Portland, Ore., Involves Use of Cribs, 68 x 78 Ft. in Plan and 80 Ft. High

CONCRETE piers for the new Burnside bridge across the Willamette River at Portland, Ore., are being poured by the open caisson method in timber cribs which are built on the river near the work, towed into place and sunk. Four piers are required, two of large size near midchannel for the draw span, and one of smaller size on either side of the draw. The two larger cribs are 68x78 ft. in plan and 80 ft. high and the smaller ones 36x68 ft. in plan and 55 ft. high. After being sunk in place a concrete seal is poured by the tremie method, bonding the base of the pier to the piles (the placing of which was described in *Engineering News-Record*, July 9, 1925, p. 53). The crib is then pumped out and the remainder of the pier is built in the dry.

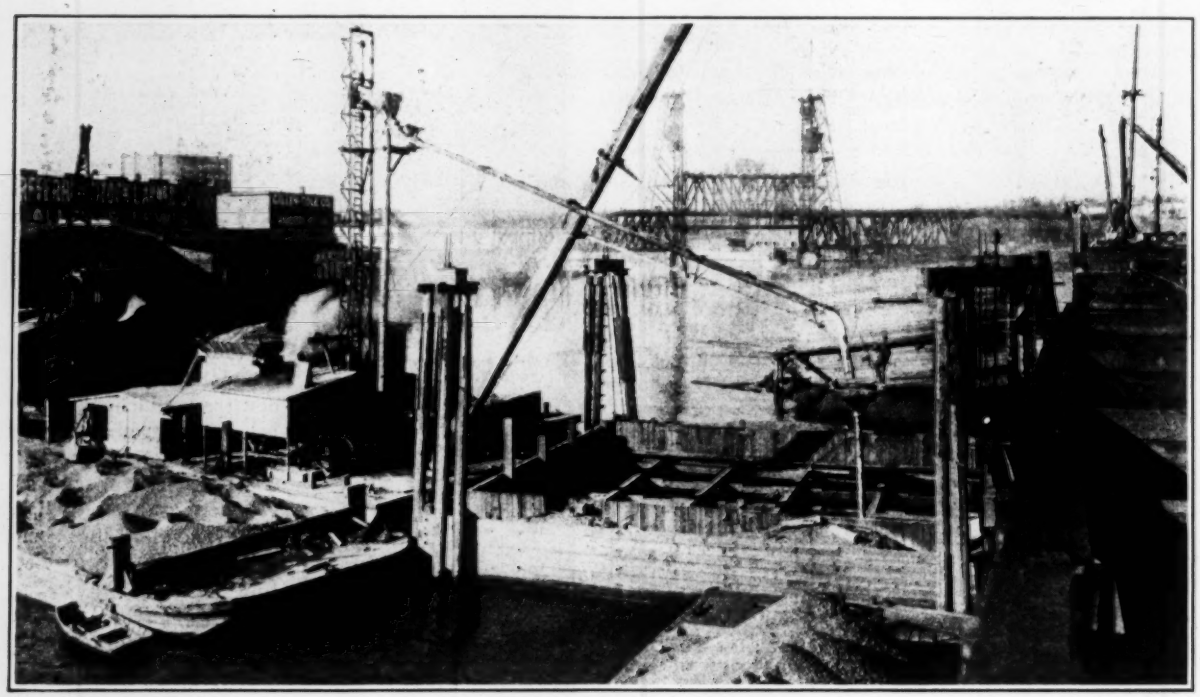


FIG. 1—PLACING TREMIE CONCRETE IN FIRST CRIB

Note long threaded rods supported on pile clusters at each of the four corners. The old draw rest appears at the right edge of the picture and the crib under construction for the next pier is moored to draw rest in background.

The new bridge is being erected on the site formerly occupied by the old Burnside bridge and the timber structure in midchannel which was used as a draw rest for the old swing span has been used by the contractors in building the new bridge. The two large timber cribs were built up at moorings alongside this draw rest which also served as a convenient location for compressor plant and stored materials.

Alongside this draw rest a cradle of piles was built as a support on which to erect the lower or first seven courses of the crib. These courses were then lowered into the water and thereafter the buoyancy of the crib was its own support, some 34 ft. of the total 80-ft. height projecting above water when the assembly was completed.

Based on previous experience the contractor believed that a system of 8-ft. bolts on 3-ft. centers was more effective in tieing the timbers of the crib together and providing for the wedging action of the calking than the ordinary drift bolts, and this method was accordingly used. No bracing was used near the bottoms of the cribs, in order that they might be floated over the tops of the piles, which projected 10 ft. above the river bottom, and there sunk to exact position. To strengthen the lower courses in the absence of bracing, heavy vertical timbers or spuds were placed on the outside of the crib walls, one being opposite each vertical post, and bolted to it through the wall.

Above this hollow base of the crib an extensive system of sway-bracing in all three planes was provided to strengthen the crib against distortion and to insure effective column action for the heavily loaded struts.

In the larger or bascule-span cribs the concrete seal was made 37 ft. thick which gave more than enough weight to balance the entire buoyancy of the pumped-out cofferdam without extering uplift on the foundation piles. This permitted considerably lighter construction in the portions of the crib against which the seal was poured and no calking was done below an elevation 6 ft. lower than the top of the seal. The height of the crib was such that a 5-ft. freeboard above ordinary low water was provided which was believed to be ample to prevent interruption of the work due to any ordinary rise in the river.

About 440,000 ft. b.m. of timber and 44,000 lb. of hardware were used in the construction of each of the large cribs. Douglas fir was used throughout with stress allowances of 1,800 lb. per sq.in. in flexure; 450 lb. per sq.in. for side compression, and 700 lb. per sq.in. for end compression, 6-in. oak bearing blocks being used at the ends of the crib posts.

Stability calculations indicated that the completed

crib floating in the water would be in neutral equilibrium. However, in view of the short distance which the crib had to be moved to final location and the ample facilities for keeping it upright while in transit, this was not thought serious. The construction plan was to sink the crib by means of weight boxes filled with material taken from the river bottom. These boxes were located inside the crib near the top to permit of easy removal. The calculated weight required to sink the crib was 440 tons.

Because of the unwieldiness of the cribs and to provide against the instability that would develop with weight located near the top, a system of 2-in. threaded rods was provided, two at each corner of the crib, which made it possible to control the process of lowering. Each pair of these rods was attached to the crib at one corner, and was supported by four piles with a cap through which the rods passed. The plan was to apply sufficient excess weight to the crib to keep these rods in slight tension at all times, so that the movement of each corner of the crib could be controlled by unscrewing the nuts on the rods as the weight was applied. Details of this arrangement are shown in Fig. 1.

To prevent an excess of weight at one corner from overloading the guide-piles and developing undue friction on the screw rods, a 6½x8-in. drawbar spring was inserted over each rod between its nut and the pile cap. These springs would close under a load of 5 tons and thus give warning to the man in each corner in case his corner was becoming too heavily loaded. An additional reason for using these springs was that the guide piles at each corner were 130 ft. long and their value as columns was problematical. In fact, no 130-ft. piles were obtainable for this purpose and it was necessary to splice out shorter piles in each case. These guide piles were braced by tieing them together with cables around the crib and they were also lashed to horizontal piles which were floated into place against the pile clusters.

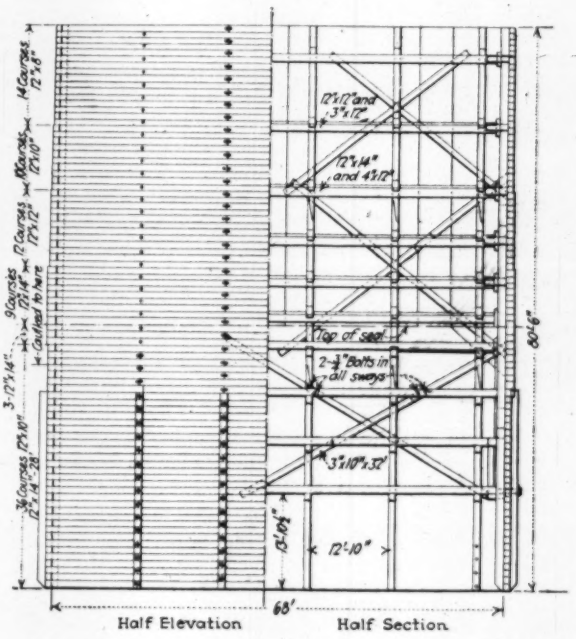


FIG. 2—ELEVATION SHOWING CRIB WALLS AND BRACING

After all preparations were made, about two days were required for the complete sinking of a crib. The work was rushed during the fall months, in hope of having the bases sealed on the two bascule piers before the winter high water began.

The contract for the work was awarded July 21, 1924; by the middle of December, in addition to the removal of the old bridge, the excavation for all but one of the smaller piers had been completed, all four cribs had been built, piles had been driven in the two bascule piers, both of the large cribs had been successfully sunk and sealed, and one of them had been pumped out and the forms for the concrete pier at this crib had been placed.

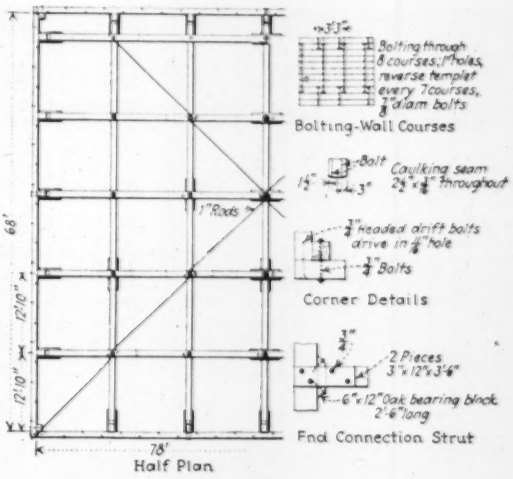


FIG. 3—PLAN OF CRIB

The contract for this work is held by the Pacific Bridge Co.; Philip Hart of that company devised the methods described in the foregoing. H. Rode is resident engineer on the work for Gustav Lindenthal of New York who is consulting engineer for the county on Willamette River bridges.

Alkalis Affect Cement-Mortar Drain Tile

The best quality of cement-mortar drain tile may disintegrate when exposed to severe alkali attacks, according to field inspections covering a period of ten years, conducted by the Bureau of Standards of the Department of Commerce. In fact, the Bureau recommends that installations of this kind in soils containing more than 0.1 per cent of salts of the sulphate type should be preceded by an examination of the surrounding conditions. These conclusions are based on inspections of experimental drain tile and concrete blocks installed at eight localities in the alkali-bearing soils of the West. The work was started in 1913, in cooperation with other interested branches of the government, and inspections were made in 1916, 1919, and 1923. Since the results of all inspections show that the quality most needed to resist exposure to alkali water is impermeability, the Bureau is now studying methods for decreasing the permeability of concrete, including the use of alkali-resisting materials. Some progress has already been made, and asphalt-coated and sulphur-impregnated tile have been prepared in the laboratory and specimens of each kind installed under severe field conditions at Montrose, Colo.

Helium-Oxygen Mixtures for Compressed Air Work

Helium Replaces Nitrogen in Air—Tests Indicate Decompression Time Can Be Shortened and Caisson Disease Mitigated

THE EFFECT of the substitution of helium for nitrogen in combination with oxygen for conditions of work under pressure is described, with results of experiments made, in a report, "The Value of Helium-Oxygen Atmosphere in Diving and Caisson Operations," by R. R. Sayers and W. P. Yant, of the U. S. Bureau of Mines, which was issued as a bulletin of that bureau. The main facts and conclusions of the report are abstracted below:

In all caisson, diving and underground work, the permissible pressures and times of compression and decompression are limited by the physiological effects on man. The speed of compression seems to be governed by the effect on the ear drums, but to experienced workers this presents no great difficulty as they can go under pressure at a rate of 15 to 20 lb. per min. The major effect arises from too rapid decompression from high pressures. In this case the nitrogen (which is the inert constituent of normal air and is absorbed by the body tissues and fluids in abnormal amounts when under pressure) tends to form bubbles in the tissues. This bubbling action is similar to that of a carbonated beverage when the bottle is opened. The bubbles are most dangerous if formed in the spinal cord and brain, causing paralysis or death. Also an additional danger is the tendency of the bubbles to increase in size on further lowering of the pressure.

Use of Helium—Any gas with a lower coefficient of solubility or (and) a greater diffusivity than nitrogen would reduce the danger of bubble formation as well as reduce the period of decompression for a given condition of exposure, but such a gas would have to be inert like nitrogen as regards physiological effects. Helium is an example of a gas of lower solubility and greater diffusivity than nitrogen and accordingly tests have been conducted on rats and guinea pigs and are now being conducted on men with synthetic atmospheres of nitrogen and oxygen and of helium and oxygen, the results of which give data as to their relative value. Hydrogen has a greater diffusivity than nitrogen but forms a highly explosive mixture with air which renders it unsuitable.

Decompression schedules for the animals were based on Admiralty Tables used in diving work. These tables were interpolated for the pressures used in the tests of which 150 lb. was the minimum. Also the period for each stage of decompression was reduced proportionately in order to eliminate both the safety factor included in the Admiralty Tables and the factor due to the difference in size between men and the small animals.

White rats were exposed to 20 atmospheres of pressure for one hour. Those exposed to the helium-oxygen atmosphere were all normal and active after decompression while all of those exposed to the nitrogen-oxygen mixture were killed by the test except one and it was paralyzed in the hind legs.

Further tests were made on guinea pigs exposed to 10 atmospheres pressure for various periods of from 1 to 5 hours. Some of the animals were killed immediately after decompression and examined for pathological changes. There were no bubbles in the tissues or veins of the animal which was decompressed in helium-oxygen atmosphere in 15 min. The same was true of the animal that was decompressed in the nitrogen-oxygen mixture in 45 min. It may be safely said that for similar effects the advantage of the lessened decompression time of helium over nitrogen is somewhere in the order of 1 to 3 or 4. It is reasonable to believe that there is a maximum decompression rate which cannot be exceeded regardless of lower solubility or more rapid diffusion because the circulatory system would be unable to carry the gas away as rapidly as it is diffused into the blood thereby allowing bubbles to form. Even if this possibility be disregarded and it is assumed that the comparative relation obtained with small animals will hold in a fair degree for men, it can be concluded that the use of helium-oxygen mixtures will greatly decrease the safe period of decompression and would thus permit men to work for longer periods. The ratio of relative decompression periods (1 to 3 or 4) is greater than can be explained from the solubility coefficients of the two gases and the difference is apparently due to the greater diffusivity of helium.

In order to ascertain whether any discomfort would be caused from breathing helium, the gas was inhaled by several of the investigators for periods up to 2 hours. There was no noticeable effect except a temporary rise in the pitch of the voice. The gas was found to be as agreeable and pleasant as normal air.

The advantages which helium has been found to possess may be employed either through supplying the men with the synthetic air throughout the working period or during a shorter period at the end including the decompression. It might also be used as a wash gas during decompression only or as a treatment if compressed-air illness has occurred with ordinary air, the benefits being due to the removal of the partial pressures of nitrogen in the medium that is removing the gas.

Summary—The results of the study may be summarized as follows:

(1) Helium-oxygen mixtures can be breathed by men without apparent discomfort and by animals without demonstrable ill effects.

(2) Helium-oxygen atmosphere theoretically has an advantage over nitrogen-oxygen atmosphere for persons exposed to high barometric pressure due to the fact that helium has a lower coefficient of solubility and a greater diffusivity than nitrogen.

(3) Animals exposed to 10 atmospheres of helium-oxygen mixture from 1 to 5 hours can be decompressed in ¼ to ½ the time necessary for animals exposed to nitrogen-oxygen mixtures at the same pressure and time to obtain similar physiological effects.

(4) Helium-oxygen atmosphere has possibilities for extended depth and time of submarine operations; also for prevention of caisson disease in tunnel and caisson workers and by using the mixture as a wash gas during decompression among tunnel workers.

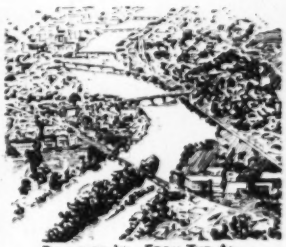
Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

Rockford, Ill.



ROCKFORD, ILL., FROM THE AIR.

COUNTY SEAT OF WINNEBAGO COUNTY, and 85 miles, by rail, west and north of Chicago. Rockford is a growing manufacturing city with good railroad connections. Some of its industries use water power. Rock River divides the city. Chief industries are furniture, sewing machine, harness and leather goods factories, knitting mills, clothing manufacture, foundry and machine shops. Rockford was settled in 1834, laid out as a town in 1836 and chartered in 1852. Increased in size in 1890 by annexation of suburbs. Pop. 1925, 80,000.

ALTHOUGH Rockford is crowding Peoria hard as the second city in Illinois it still handles its public improvements (for economy's sake) under the law provided for cities having a population of 50,000 or less. Economy of administration and recording that economy in understandable form strikes one as decided features of the Rockford city engineer's job. With that go carefulness of construction, rigid enforcement of contract specifications and a certain amount of force-account work, also a well-organized maintenance department.

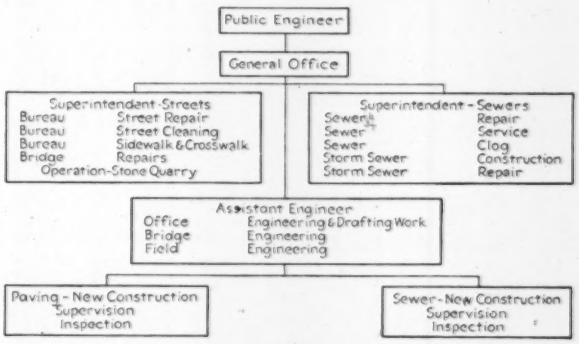
Because of the decentralized business district with consequent low buildings Rockford has the appearance of being a much smaller city than it really is. This characteristic considerably increases the downtown street problem, particularly as to heavy-traveled thoroughfares. While the rapid growth of Rockford must be attributed to its industrial development one does not think of it primarily as a drab factory town. Perhaps the grade of citizenship in the furniture factories which rival in output those of Grand Rapids, Mich., is higher and the care which the workman gives his own home is reflected in the good municipal housekeeping observed in the well-paved and cleaned streets.

Located about equally on the east and west sides of the Rock River on rolling bluffs eroded from limestone substrata or glacial deposits of the terminal moraine, Rockford is especially favored from the engineering standpoints of good drainage, sufficient grade, excellent foundations and no particular problems in street excavation. About 30 per cent of the cover is clay, 25 per cent sand, 30 per cent gravel and the remainder rock. Except in rock which is handled by paving breakers, machine trenching and backfilling are practiced. Road materials from quarry and pit are thus easily available.

The population of Rockford has shown both a steady and rapid growth. In 1910 it was 45,000, it jumped to 65,176 in 1920 and is 80,000 now. The location of Camp Grant south of the city with provision for training 45,000 soldiers gave the city a heavy influx of population in 1917 and 1918 which it has largely kept and no material slump has since been observed.

Where the engineer fits in in the city administration is to be noted on the organization chart. Engineers for boards of local improvement in Illinois are officially and aptly designated as public engineers. Bernhard C. Harvey, who holds that position, is also city engineer. He is a member of the Board of Local Improvements with the mayor and superintendent of streets, all serving without pay. Ordinarily five citizens on salary are appointed by the mayor. All engineering and engineering maintenance, aside from the water-works and garbage handling, are under his charge. He supervises street maintenance, street cleaning, sidewalk and curb construction. His staff consists of sixteen inspectors on new construction, three field parties of three men each, two assistants on special assessment work of paving and sewers and two draftsmen in the office.

Financing in Rockford is done largely under the special assessment law for paving and sewer work. Bridges are built from bond issues, special benefits to property owners being considered too difficult to evaluate to attempt raising a part by this means. Bonds were issued to buy and equip a city yard. The city owns and operates a stone quarry from which it sells stone to paving



ORGANIZATION CHART, ENGINEERING DEPT., ROCKFORD, ILL.

contractors at a price fixed in the contract. The money for the purchase of this quarry was taken out of the street repair funds.

Sewerage—Sewage conduits consist primarily of vitrified tile pipe with machine-made concrete pipes for the storm-water drains which are now laid consistently under all new paving. The city is beginning to develop separate systems for sewage and rain water since eventually sewage intercepters skirting the river will have to be built to a proposed disposal plant below town. All new work conforms to a tentative plan, which will soon be taken up by a sanitary district comprising considerably more area than the city itself.

Earth disposal is a problem of no small proportions in many towns. Chicago has been making lake front parks for years and the end is not yet. The Rockford Health Department which handles garbage, maintains seven dumping places, old gravel pits and low land along the river. Lot owners along streets that are being graded down are given the excavated earth without charge if they desire it.

Snow removal, like the earth, goes to old quarries,

pits and the river. Snow is mechanically loaded into trucks. The loader is also employed to load cinders for use of the maintenance department on unpaved streets. The truck is only two minutes in loading. Like every other piece of equipment, such as street sweepers and sewer cleaners, a cost accounting with amortization, depreciation and upkeep is made and Mr. Harvey says the city has not a single piece of equipment which has not saved more than it cost over hand operation.

Surveys are now under way to complete a new 150-ft.-to-the-inch topographical map with a 2-ft. contour of the city for future use in making a sanitary survey. Where street profiles are not sufficient, complete topography is undertaken to give 2-ft. contours. Forty-six plates are being drawn up, each plate representing one square mile. When completed it is the intention to photograph each plate and make a small mosaic of the whole city for ready reference.

Hanging on the wall of Mr. Harvey's outer office is a topographical contour representation of the city made up of heavy cardboard, a separate sheet for each contour. Since the elevations vary by 2 ft. the thickness of the model is several inches. To bring out different levels on the 1-mile plates Mr. Harvey colors the area between contours. Aerial photographs he does not believe give accurate enough information for this purpose.

Paving and Materials—Rockford has been and still is doing a large amount of paving of all kinds besides caring for its old work. All kinds are being laid, a bitulithic top seems to be the preference of the property owners, who wish an asphalt pavement. Brick is still being laid. A drive over considerable mileage of newly-laid brick indicates that Mr. Harvey believes in close joints, bitumen filled. The concrete base of 1:3:5 concrete must be screeded to a fraction of an inch of the grade. The 1½-in. sand cushion has no cement in it. Like the concrete pavements, all of which are reinforced with heavy mesh and liberally provided with expansion joints, asphalt filled, the riding qualities of the brick are excellent.

Concrete is the hardest pavement to build right, in Mr. Harvey's opinion, principally because everything must be done right from the subgrade up, and it all goes in at once. With bituminous tops, inspectors and the operator of the roller follow each other until the ¼-in. tolerance with a 10-ft. straight-edge is obtained. Brick can be culled up to the last minute before applying a filler. In this connection may be noted one of the city engineer's problems. A contractor objected to the rigidity of enforcing the brick specifications and threatened to bring out a representative of the brick association. Mr. Harvey welcomed the suggestion. When the inspector came he quite agreed with the methods pursued.

As in many other cities that relic of the crossing walk in the form of a raise in the pavement is being abolished in Rockford. Automobile speed, the necessity of utilizing the full width of the street and use of mechanical street sweepers have made raised crossings a decided nuisance. The average cost of cutting down crossings of brick on concrete was $44.46; the area involved is usually about 18 sq.yd.

All new curbs are of the integral type, ogee in section with a 7-in. curve at the bottom and 6-in. at the top, joined by a 1-in. tangent. Where other than concrete is laid the curb is laid first with 36-in. width, the slab portion being 6 in. thick. This makes the back of the curb 14 in. deep. A crawler-mounted concrete mixer with chute to the forms was laying about 800 ft. per day when one of the jobs was visited. At first this curb was considered hard to build by the contractors but soon was found no more difficult than the ordinary straight side curb. Steel forms with templet spacers midway between templets forming expansion joints 24 ft. apart are filled with a concrete having a 1¾-in. slump. The concrete is banked against the back form, screeded off, dry cement thrown on it and then troweled from the back. This type of curb greatly facilitates street maintenance with a mechanical sweeper, permits automobiles to ride over it easily in case of necessity and permits parking of cars closer to the curb.

Engineering Work

New street grades, which determine curb grades, are set first and made to serve the traffic, while sidewalk grades are set to serve the property owner, though for drainage of the parkway they are never less than 4 in. above the curb. This policy permits terracing if the owner so desires where the street has been cut down. Street grades vary from 0.3 to 17 per cent. All work is carefully cross-sectioned before contracts are let so exact yardages can be computed.

Not so long ago broken stone in Rockford became quite precious and Mr. Harvey decided to reopen an old quarry which the city owned. He built a substantial crusher, motor-operated, a screen and storage house, a runway 300 ft. long down to the quarry floor over which two 1½-yd. cars are operated alternately by a double drum hoist. Stone is furnished to contractors at $1.75 per yd. delivered. Operations in the quarry consist of shooting down about 8 ft. in height at a time onto a very level floor. Larger pieces are broken by hand or pot-shotted. A loader refitted onto a tractor with stiff uprights fills the cars. Never more than 8 men work in the quarry. The output is about 125 yd. per day.

Maintenance or patrol crews go over all streets. Patches of asphaltic macadam are made where necessary. A heavy coat of bitumen has been given the old macadam streets that are not too rough, otherwise they are scarified, reshaped, rolled and then given a bitulithic top for best work. On others a series of three asphalt penetration coats is given. Aside from the several car line streets the city's pavements are in good condition. Since a new franchise was granted the traction company in June which calls for substantial track foundations, these streets can now be put into condition. Since the city itself will lay the wearing surface, uniform paving can be obtained.

Though a comparatively young man, Mr. Harvey has been in the city engineer's office ten years, half of the time as chief. He believes in publicity of the right kind and particularly of paving work. Sewer construction is too difficult to understand by the ordinary layman so he does not attempt to give out much on that line. For the technical press he has written several articles recently on costs.

An ingenious gravel spreader of his own design was described. It consists of a hopper box on four wheels to be used as a trailer. The 8-ft. width enables it to cover the swath of an oiling machine. At the bottom of the hopper are slotted openings controlled as to size by lever. The gravel drops on an angle bar and is spread evenly.

Of the Small City

Sewage Disposal for City of 3,000 Persons

BY F. M. VEATCH
Black & Veatch, Consulting Engineers, Kansas City, Mo.

HOLDREGE, Nebraska, a prosperous town of approximately 3,000 people, located in a productive agricultural district, was one of the first of the smaller Nebraska towns to construct a sanitary sewer system. This system, built in 1907, included no further provision for sewage disposal than the box type septic tank in vogue at that time which was expected to purify the sewage completely. Since its construction, this system has been extended from time to time to meet the growing needs of the city until at the present time approximately 70 per cent of the population is served, and the sewage flow amounts to approximately 260,000 gal. per day. Sewage, after passing through the septic tank, is discharged into an intermittent water course which meanders in a southeasterly direction and finally ends in a "sink hole" some seven miles from the plant.

Under the current conception of sewage disposal, these conditions call for complete sewage treatment: that is, settling followed by nitrification, since the supply of diluting water is intermittent. There exist offensive sludge banks along the water course, and

IMHOFF TANK AND SLUDGE BED AT HOLDREGE

general septic conditions in the stream made it evident that the septic tank treatment as afforded by the old tank is little better than no treatment at all. Surprisingly little complaint has been made about the conditions and until recent years they seem to have been regarded as a necessary evil, but in 1923 repeated complaints by farmers in the neighborhood and by the state health authorities caused the city officials to realize that the nuisance must be abated.

Engineers were employed, who after a survey of the situation, recommended a treatment plant to consist of Imhoff tanks, sprinkling filters and final settling tanks with the necessary sludge drying beds and pumping plant. Further use of the old septic tank was not recommended since no provision was made for removal or for drying sludge and the design is not proper for good sedimentation.

The Imhoff tank is designed for 3,000 persons or a flow of 300,000 gal. of sewage per day with a settling period of three hours in two parallel flow chambers, and a sludge digestion capacity of 2 cu.ft. per capita. The sludge bed has a capacity of 1 sq.ft. per capita. The sprinkling filters are designed on a basis of 3,000 persons per acre per foot of depth, or practically 0.54 cu.yd. of stone per capita. The depth of stone is 6 ft. and the nozzle spacing is 12 ft. Circular spray nozzles are contemplated.

The proposed final settling basin is rectangular in plan with a hopper bottom designed for horizontal flow between inlet and outlet weirs. The detention period is 15 min., or practically the period between doses.

Lack of available funds prevented the construction of the entire plant and only the Imhoff tank and sludge bed as shown in the photograph herewith have been constructed so far, the remainder to be built within a few years. The Imhoff tank and sludge bed were constructed by the Asplund Construction Co. of Tecumseh, Nebraska, at a cost of approximately $11,000. Plans and specifications were prepared and the work was supervised by Black & Veatch, of Kansas City, Mo.

Does 100 Per Cent Metering of Small Town Water Supplies Pay?

A NUMBER of salient features of metering water supplies were discussed at a late meeting of the North Carolina Section of the American Water-Works Association by F. V. Fields, superintendent, water and light plant, Mooresville, N. C. They follow:

The question in hand could be easily answered if it did not specify small town; with the mass of statistics available as to the consumption of water in metered and unmetered cities, there can be little doubt in the mind of water-works men as to the value of 100 per cent metering for cities.

There is, between the small-town water-supply system and that of the city, a certain analogy, which can give the small town a lesson that many cities have learned at great expense. For example, take the city of Chicago, an extremely bad example of a partially metered water supply. The consumption of water in Chicago in 1923 was 294 billion gallons; 83 billion gallons were metered; that is, about 30 per cent, which brought in $5,500,000, approximately, while the remaining 70 per cent brought in $3,500,000 approximately. Whereas the consumption per day should be 150 gallons per capita, it is 275, with a peak load of 400. There are many cities that have cut their consumption in half by 100 per cent metering. There are many small towns of today which will grow into cities. By adopting 100 per cent metering as small towns they will save millions of dollars.

But considering the small towns as such, will 100 per cent metering pay as an investment? Assuming that it will not and that only wasteful customers and large users will be metered, who shall decide which is the wasteful customer? If meters are installed at the request of the customer, it will be the careful, saving man who will insist on having a meter, so that, unless authority is given to the water department to place a meter on any customer, there is no need for metering whatever. The customer who asks for a meter expects to reduce his own bill.

As an investment a meter must save enough water to pay for depreciation and interest on the investment. The investment will be about $15 per dwelling service. Considering the life of the meter as fifteen to twenty years, the depreciation will be about 6 per cent and for a return of 6 per cent, a total of 12 per cent or $1.80 must be realized each year per meter. The average water rate for North Carolina is 30 cents per 1,000 gal., which calls for a saving of 6,000 gal. per meter, only 500 gal. per month. One or two leaky fixtures, a few minutes a day with the hose, letting the water run to prevent freezing, any of these and many other wasteful practices will far exceed the 500 gal. per month needed to insure a return on the meter. Furthermore, the economical water user is not required to pay a proportion of the additional expense entailed by the wasteful habits of his neighbors.

Coastal Highway Crossing of the Savannah River Delta

Five-Mile Causeway Over Marshes and Channels Composed of Earth Fills, Concrete Trestle Bridges, and Steel Swing-Span—Foundations of Large Precast Concrete Piles—Construction Difficulties

By Searcy B. Slack
Bridge Engineer, State Highway Department, East Point, Ga.

THE CROSSING over the Savannah River between Georgia and South Carolina near Savannah, Ga., forms a very important link in the great Coastal Highway which is being constructed to connect the cities along the Atlantic seaboard. This river and its delta have been one of the main obstacles to highway traffic, and with the development of the South Atlantic coast as one of the principal winter playgrounds of America there has been an increasing demand by tourists as well as local interests for the construction of this project. There has been no satisfactory crossing of this river south of Augusta, 125 miles upstream. Wide marshes make the approaches to ferries difficult to maintain, and the crossings are frequently interrupted.

The southern corner of South Carolina is strictly agricultural and is sparsely settled. Until state and federal aid funds were available it was impracticable to finance the project. Late in 1920 a financing agreement was reached between Beaufort, Jasper and Hampton counties, South Carolina, and Chatham county, Georgia, and the state highway departments of Georgia and South Carolina. Work on surveys began early in 1921.

By agreement the engineering on the project was handled entirely by the Georgia highway department. The interstate bridges between Georgia and South Carolina have been handled alternately by the two highway departments. This method eliminates confusion in dealing with the contractors and in handling details of construction.

Location—The City of Savannah and Chatham county, that provided nearly one-third of the funds, urged that the location of the bridge be as close to the city of Savannah as practicable. The port and shipping interests of the port of Savannah opposed the location of another bridge within the limits of possible harbor development. Three public hearings were held by the district engineer of the War Department. The location first proposed is parallel to the crossing of the Seaboard Air Line Ry., about 2 miles above the city. The second location is just above the plant of the Federal Marine Railway Co. on Kings Island, about 4 miles above the city. The third location, which was finally approved and adopted, is just south of the mouth of Augustine Creek, about 8 miles above the city. The first two locations were disapproved by the War Department because of protest from the state port commission and other shipping interests that a bridge at either location would unduly interfere with the future development of the harbor. The location of the Seaboard Air Line bridge within the harbor limits has, it was contended, interfered to some extent with the port development. While a location nearer the city would have been more convenient for local traffic, the distance between Charleston and Savannah is not materially increased by the location selected, and as the bridge is well above any possible harbor development the draw will not be opened frequently enough to affect highway traffic.

Conditions at Site—The interstate project included all necessary construction from high ground in Georgia to high ground in South Carolina, a distance of 24,375 ft. or 4.6 miles. At this crossing there are three streams or rivers through the delta, two large canals and several small canals which were formerly used by rice planters. Beginning on the Georgia side the streams are known as Front River, the main channel, width 1,000 ft.; Middle River, 550 ft.; and Back River, 300 ft. All navigation, with the exception of an occasional bootlegger's boat, passes through the main channel of Front River. The War Department has placed low-water obstructions at the lower ends of Middle and Back Rivers so as to force the current, at ordinary stages of the water, through the channel in Front River. Between the rivers there is low marsh land, generally 3 to 4 ft. above sea level (mean sea level at Savannah). From the east side of Back River to the South Carolina highland, 3 miles, there is a series of old rice fields and an occasional canal, the average elevation being from 3 to 5 ft. The ordinary tidal range at the bridge site is 5 ft., but high water reaches an elevation of 9.5 ft.

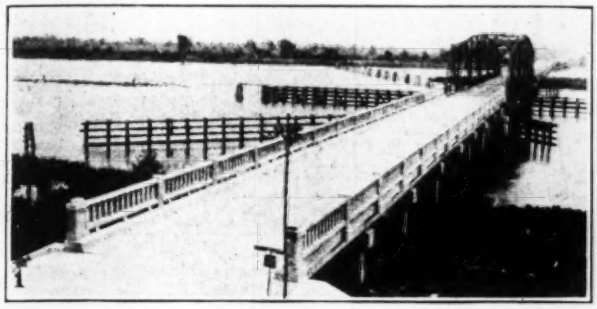
Wash borings showed sand with a few strata of blue clay and some sandstone in the rivers. In the marsh between the rivers there is 10 to 30 ft. of soft silty material overlying compacted sand. In the old rice fields there is 5 to 20 ft. of the soft material overlying the sand. The marsh land and old rice fields are so soft that a man mires up to the knees and sometimes above the waist in walking through them. At several places the semifluid mud is 10 to 20 ft. in depth. Surveys were made at low stages of the tide, but the unstable material made surveying hard and unpleasant.

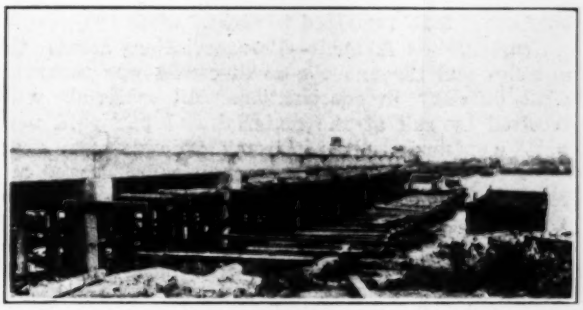
Traverse surveys were made along the edge of the marsh on both the Georgia and South Carolina sides and preliminary lines were projected across the marshes. As far as practical these lines followed the old rice dikes, which afforded stable ground for instrument work. A map was then plotted, showing the stream banks, canals, and edges of the marsh, and a location was projected on the map. A location survey was made on this projected line through the marshes and old rice fields. The stakes used were about 8 ft. long and were churned into the marsh by two men. It was impossible to locate stakes accurately at station points, so the distance between successive stakes had to be recorded separately. At transit points platforms supported by stakes 8 to 10 ft. long were built. One platform was built for the transit and around this an entirely independent platform was built as a stand for the transitman so that he would not disturb the instrument by movement. In spite of these precautions shifting of the points in the soft mud was a constant source of annoyance, and it was necessary to check and recheck the line and river triangulations several times.

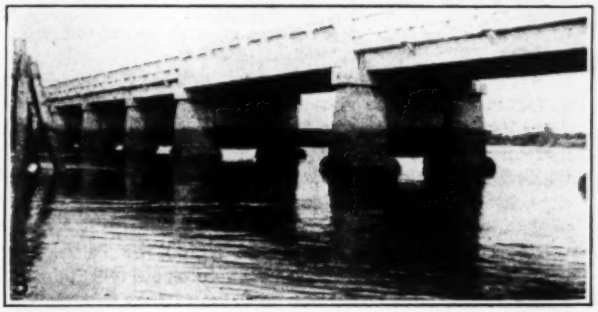
Determination of Waterway—At extreme high water the entire marsh land and old rice fields from high-

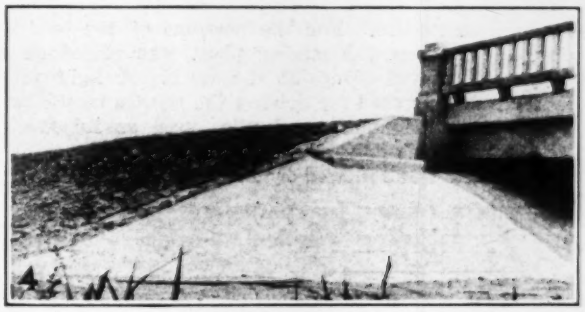
land to highland, a width of 4.6 miles, is covered with from 4 to 7 ft. of water. The direction of the wind and the stage of tide have a very marked effect on the direction and strength of the currents. There are a number of old dikes built by rice planters many years ago which gave good data on the currents to be expected. The actual determination of location and length of openings was based upon data from these old dikes, the depth of the soft material overlying the sand, and the experience of the Seaboard Air Line at its crossing about 6 miles downstream.

A record-breaking high water in January, 1925, after all of the fill and practically all of the bridges were complete, caused several breaks in the fill near the South Carolina end of the project. Falsework was still in place under Bridges 4 and 5, which materially









FIGS. 1-4—FOUR VIEWS OF THE JUST-COMPLETED SAVANNAH DELTA CROSSING OF THE COASTAL HIGHWAY

Fig. 1—West end of Bridge 1, showing swing-span over Front River. Fig. 2—West end of Bridge 1 during construction; construction trestle and falsework supports still in place. Fig. 3—Part of Bridge 3 showing 48-ft. through-girder channel span and 35-ft. deck-girder spans on short piers. Fig. 4—Grouted riprap at end bent.

obstructed the discharge through these two openings, and a jam of old falsework timber caused underscour at Bridge 4, resulting in the loss of two decks and two bents. There was no material damage from the freshet to the three main bridges or to the fills west of the break at Bridge 4. As a precautionary measure it was decided to lengthen Bridge 4 by extending it 200 ft. west and to add a bridge 350 ft. in length between Bridges 4 and 5.

The lengths of the bridges, 1 to 6 respectively, are 1,466 ft., 1,815 ft., 1,988 ft.; 400 ft., 200 ft. and 350 ft.; total length of all bridges, 6,219 ft. The discharge area below extreme high water (El. 11.3) is approximately 54,000 sq.ft. Of this approximately 25,000 sq.ft. is between the banks of the three rivers, while 29,000 sq.ft. is over the marsh land.

The streams are not deep and carry very little drift. The range from low to extreme high water is 11 ft. and the current at high water is estimated to be 3 miles per hour.

Bridge Design—With the exception of the steel swing-span over the main channel, the bridges are concrete trestles supported by precast concrete pile bents. For the main channel a horizontal clearance of 100 ft. was required for navigation, and this is provided by a 240-ft. riveted center-bearing swing-span supported on concrete pivot and end rest piers. The main piers are protected by creosoted timber fenders and the concrete approach trestle is protected by a series of cypress pile clusters. The width of the roadway on the bridges is 20 ft. between railings and 18 ft. 6 in. between curbs. The bridges are designed for a live load of two 15-ton trucks abreast; an allowance of 30 per cent was made for impact.

The concrete trestle over the marsh consists of a series of deck-girder spans 25 ft. long, supported by bents of four precast concrete piles (Fig. 5). The spans over the deeper water in the rivers are 35 ft., long, and they are supported by short concrete piers. The short piers (Fig. 6) are carried on six concrete piles, which were driven and cut off at extreme low water and capped, and the short piers were constructed on these caps. This type of construction was used to secure stiffness for the piers and to avoid the long unsupported lengths of piling between stream bottom and girder seats.

The precast concrete piles are square in section, 14x14 in. for lengths not exceeding 26 ft., 16x16 in. for lengths of 27 ft. to 36 ft., and 18x18 in. for lengths over 36 ft. The 16x16-in. size was used in all end bents. The main reinforcing for the 14-in. piles is four $\frac{7}{8}$-in. round rods, for the 16-in. piles eight $\frac{3}{4}$-in. rounds, and for the 18-in. piles eight $\frac{7}{8}$-in. rounds; the main reinforcing is hooped with No. 8 wire spaced closely near the ends of the piles and 6 in. apart in the middle section. The steel has a minimum covering of $2\frac{1}{2}$ in. of concrete.

Due to the rather uncertain lateral support afforded

by the soft marsh a rather light loading was used for the piles: 23 tons per pile in the four-pile bents and 26 to 27 tons per pile under the short piers.

At the ends of the bridges six-pile bents were used, the earth fill extending between the piles. The specifications required the fill to be completed first and excavation to be made in the fill for driving the piles and constructing the caps for the end bents. This provision was made to prevent movement of the bents or stresses in the piling due to movement of the unstable material under the weight of the new fill. The softness of the marsh material is illustrated by this incident: During construction a 40-ft. concrete pile was accidentally dropped on the marsh while being lifted into the leads. The pile struck the marsh head down at an angle of about 45 deg. from vertical and of its own weight sank into the marsh at about this angle until only about 8 ft. remained in sight.

Construction Methods—Transportation across the marshes and through the small canals was the principal difficulty in construction. All materials were received by rail at the material and pile yard near Port Wentworth, about 2.5 miles downstream from the bridge. The materials were unloaded, stored and reloaded on barges to be towed to the job as needed. The concrete piles were cast and cured in this yard.

A service trestle was built parallel to each bridge and a portable mixing plant was moved along the service trestle as the work progressed. The materials were unloaded from the barges to tramcars and pulled forward as needed. For the portions of the bridges over the streams the mixing plant was placed on a barge and moved alongside the work. A light piledriving rig was used for driving the service trestle and intermediate bents of wood piles used as falsework. The crew of this driver built the trestle.

This crew was followed by the heavy piledriving rig

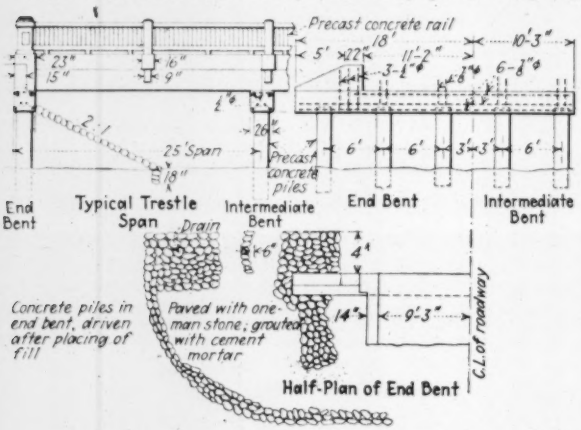


FIG. 5—BENTS OF CONCRETE TRESTLES, SAVANNAH RIVER CROSSING

Four-pile bents carrying 25-ft. concrete girders are standard for marsh trestle parts of this crossing.

used for handling the concrete piles. The rig consisted of a heavy single-acting steam hammer, hoisting rig, pumping equipment and two 2-in. jets. The striking part or ram of the hammer weighed about 5,000 lb. and the two jets had a combined capacity of about 800 gal. per minute. The heavy piledriving crew was followed by the concrete crew, which cut off the piles, cast the caps and built the concrete decks. As the decks were alike the forms were made in sections and used an average of about five times each. The forms for the rail posts, pickets and top rail were made of rather heavy galvanized sheet iron and proved very satisfactory. It was found necessary to use a heavy timber and a system of wedges to secure a good line on the top rail.

The experience in handling and driving the concrete piles on this job emphasizes the advantage of a heavy,

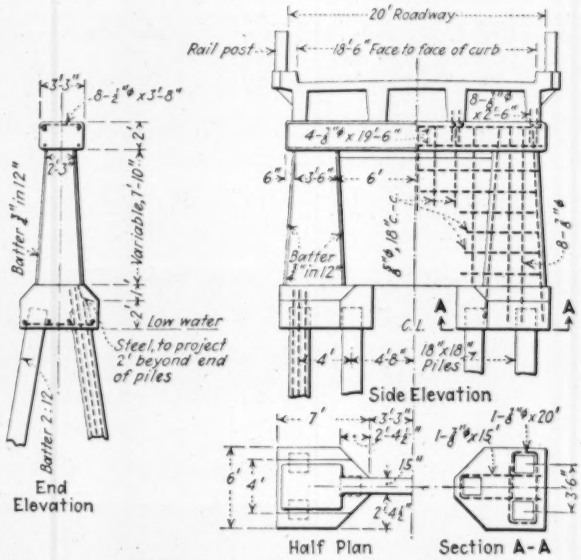


FIG. 6—PIERS ON CONCRETE PILES, RIVER SECTION OF CROSSING

Six-pile foundation capped with a short pier, used to carry 35-ft. girder spans.

strongly built rig for this work. The rig used was satisfactory for the shorter piles but was taxed to its capacity in handling the long piles. Much time will be lost on any job when it is necessary to nurse the rig while handling and driving the piles. Ample pumping capacity for the jets also facilitates driving the piles, particularly in compacted sand.

The concrete piles were cast a foot or two longer than the estimated lengths so as to avoid "build ups." Many of the piles could not be driven to grade. Several methods of cutting off the piles were tried. The quickest and cheapest was to drill a hole in the side of the pile, 8 to 10 in. deep, about 15 in. above the cutoff, load the hole with ¼ to ½ stick of dynamite, and shoot. The shot would shatter the concrete away from the reinforcing steel, and for a distance of 6 to 10 in. below the hole. The steel was cut with a torch and the remaining concrete above the cutoff was removed with a sledge hammer.

Earth Embankments—Two methods were used in constructing the earth embankments across the marshes. The fill from the South Carolina highland to the east end of Bridge 3 (about 3 miles) was built by dumping from a temporary trestle; the fills between Bridges 1 and 2 and Bridges 2 and 3 were made by hydraulic dredging from the rivers. The material for the dumped fills was a good quality of sandy clay obtained from a borrow pit. The hydraulic-fill material was coarse sand with an occasional stratum of blue clay.

An unusual amount of settlement was anticipated, due to the unstable marsh. Effort was made to cause as much settlement as possible to take place during construction, while the materials could be readily replaced. As soon as the dumped fill was brought up to the level of the temporary trestle the stringers and

caps of the trestle were pulled out, so that the cross-ties rested directly on the fill, and the track was then shifted so as to widen the fill to full 28 ft. The loads and impact from the 60-ton locomotives and 12-yd. dump cars served to settle and stabilize the fills. Very little settlement has occurred in this portion of the fill since it was completed nearly a year ago. During construction of the fills at several places the adjacent marsh ground bulged up in low ridges, indicating a displacement of the mud under the weight of the fill. Based upon borrow pit measurement and a measurement by cross-section of the embankment above the marsh the shinkage or settlement of the embankment was approximately 30 per cent. In other words 1.3 cu.yd. of borrow was required for each cubic yard of embankment above the marsh.

In constructing the hydraulic fill the material was pumped in along the center line and allowed to run, little effort being made to dike it up. Pumping was continued until the fill at the center reached about El. 8 to 9, or about 4 to 5 ft. above the marsh, and the material spread over a width of from 200 to 300 ft. The fill was then completed to El. 12 by bringing in the material from each side. As the fills were built up considerable settlement took place. It was necessary to bring the fill up to grade in certain stretches as much as three times during the three-month period of maintenance required by the contract.

The fills extending through the end bents are protected by heavy grouted riprap, and Bermuda grass has been planted on the slopes of the sand-clay fill. The protection of the slopes of the sand fills was quite a problem until it was discovered that the swamp muck would make excellent slope protection. A 6-in. layer of this muck was placed on the slopes and shoulders of the sand fills and it has effectively checked any wash of the fills. During the extreme high water in January, 1925, practically no damage was done to the fills protected by the muck, in fact this muck afforded better protection than ungrouted riprap.

About 500 crepe myrtle bushes, 1,000 canna bulbs, 200 wild olive bushes and several hundred magnolia and holly trees have been set out at intervals along the shoulders of the fills, and about 400 willows along the toe of the slopes. A surprisingly large number of these sets have lived, and it is hoped that these shrubs and trees will in years to come add materially to the attractiveness of this project as well as to the stability of the fills by binding the soil with roots.

Quantities and Costs—The principal items in the several contracts and the contract unit prices were:

243,000 cu.yd. of earth embankment measured above the marsh, at $0.65 per cu.yd.; 5,500 lin.ft. of 14x14-in. concrete piles, at $3.10 per lin.ft.; 19,500 lin.ft. of 16x16-in. concrete piles, at $3.50 per lin.ft.; 6,500 lin.ft. of 18x18-in. concrete piles, at $4.07 per lin.ft.; 7,220 cu.yd. of class A (1:2:4) concrete, at $19.58 per cu.yd.; 11,862 lin.ft. of concrete railing, at $2.10 per lin.ft.; 1,080,000 lb. of steel reinforcing at $0.049 per lb. All cement was furnished by the state, so that the unit prices do not include the cost of the cement.

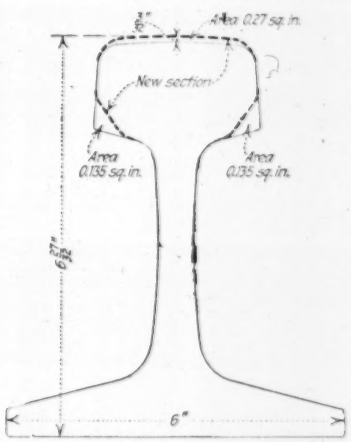
The cost per lineal foot of the concrete trestle complete was $62.80, and the cost per square foot was $3.40.

The total cost of the entire project $685,000.

Personnel—Engineering on the project was handled by the Georgia highway department under general supervision of W. R. Neel, state highway engineer, and immediate supervision of the writer. B. P. McWhorter was division engineer and C. E. Layton and L. B. Ackerman were resident engineers. The principal contracts were with A. J. Twiggs & Sons for earth embankments and Olaf Otto for the concrete trestle and pier work. B. Beasley and G. Wollen Webber were in charge of the concrete trestle work for the contractor.

New Rail Head Being Rolled

IN A proposed new rail section, of which the first lot has just been rolled and which is shown by the accompanying drawing, the lower sides of the head are cut away or beveled and the material thus saved is applied to the top of the head. This form of section is designed especially for use with the "head-free" type of rail joint described in *Engineering News-Record*, Oct. 2, 1924, p. 537. Since the splice bars in this joint have no contact with the rail head, but slope away from the top fillets, the metal in the lower corners of the head serves only to stiffen the head and does not give any direct support, and it is the idea of the designer that this metal will be more serviceable if distributed over the wearing surface of the head. From the drawing, which shows a comparison of the A.R.E.A. 130-lb. rail section with the new section of equal weight, it will be noted that 0.27-sq.in. of metal is removed from the lower corners of the head, while the same amount is added on top of the head, increasing the depth of head by $\frac{3}{32}$-in. The percentage of metal in the head remains the same, but a higher moment is obtained by the altered distribution.



RAIL SECTION
Head unsupported by splice bars.

On the basis of observations of wear of A.R.E.A. 130-lb. rails on a 9-deg. curve, it is estimated that the additional $\frac{3}{32}$-in. of metal to resist abrasion by the wheels will increase the life of the rail by 20 per cent or more. For the new rail it is claimed also that it has a better section for rolling, since it does not require the provision of a fishing surface under the head and thus permits a better working of the head metal when being rolled. This new rail has been developed by the Thomson Rail Corporation, New York, N. Y., and 6,500 tons of the 130-lb. section have been rolled for the Philadelphia & Reading R.R.

Large Lock for Port of London Approved

The Port Authority, London, England, has announced that it has decided upon the details of the new entrance lock at Tilbury Docks, mentioned in our issue of Aug. 13, 1925, p. 273. The new lock will be 1,000 ft. long by 110 ft. wide and will have a depth of water over the sill at high water of 45 ft. 6 in. The scheme will cost something over $8,000,000 and the Port Authority states that the financing practically has been arranged, and it is in a position to proceed with the work.

Survey Control in Driving 3-Mile Water-Supply Tunnel

Detailed Explanation of Instrumental Control of Alignment and Grade in Hard-Rock Bore in Rhode Island—Careful Methods Lead to Small Variations When Headings Meet

By Richard R. Bradbury
Water Supply Board, Providence, R. I.

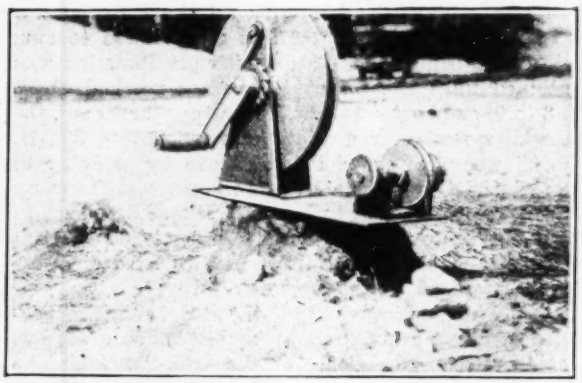
THE Water Supply Board of the city of Providence, R. I., is obtaining a new water supply for the city from the north branch of the Pawtuxet River, about twelve miles west of the city. An earth dam is being built at Kent, R. I., which will impound about 37,000 m.g. of water. From this dam an aqueduct leads to the present mains, the first part of which consists of a hard rock tunnel about 3½ miles in length, piercing the high land just east of the Pawtuxet River. The tunnel is horseshoe shaped, 7 ft. high and 7½ ft. wide inside the concrete lining. It is in hard rock for the entire distance, built to a level grade for the greater part, and is straight except for one angle of about 14 deg. at about one-third of the way from the upstream portal. There is one shaft, sunk for construction purposes. This shaft is located near a crossroad and is nearer the east than the west portal. The angle is in the west or longer portion of the tunnel.

The contract for building this tunnel was let to the Keystone State Construction Co. in September, 1922. It decided to do the greater part of the excavation from the shaft and started work at that site about the first of the month. It became necessary therefore to give the contractor line and grade from this shaft in either direction for a distance of about 6,600 ft. to meet tunnels driven from the portals, the tunnel from the east portal being about 600 ft. long and that from the west portal about 3,600 ft.

I was put in charge of this work for the city in August, 1922. As this was my first tunnel job I endeavored to obtain as much information as possible from books on tunnelling, but found that they were devoted mostly to construction methods. Shortly after the work was started, however, I visited the engineers of the Shandaken Tunnel and obtained a great deal of useful information which, with slight modifications to suit the particular conditions was used on my work.

The center line of the tunnel had been run out before I took charge. Property monuments had been set on this line and the distance between monuments obtained by precise chaining. The monuments were of precast concrete, 6 in. square at the top, 9 in. square at the bottom, and 3½ ft. long. They were set in 1919 with their tops nearly flush with the ground and we found in 1922 that a number of them had become covered with several inches of earth.

Running Center Line—Our first work was to rerun the center line. We attempted at first to do this by using the centers of two monuments near the east portal for a base, running a trial line from there until it diverged too much from the old line—as shown by other monuments—proportioning the discrepancy along one end of the base, and trying again. We lost considerable time over this and soon abandoned the method. The adjusted lines would run off just about as badly as the previous ones. We therefore took two likely points at about the midlength of the tunnel, ran out a line from these points in each direction and adjusted it over its entire length after the portals were reached. These two points were both tacks in 2-ft. oak hubs that had been set in 1919. The first lines run from them checked fairly well at the portals and I doubt if they had been moved appreciably. In running these lines we found that we obtained the best results by using only moderately long sights so that a plumb bob string could be seen distinctly and set accurately with the transit.



WIRE REEL FOR LINE DROPPING INTO SHAFT
Wire is kept wound on the reel at the back and is led over the grooved wheel in front. The axle of this wheel is a screw so that the wheel can be moved sidewise by turning the milled head on the left. At the right, behind the grooved wheel, is a lock nut which holds the wheel rigidly in place after it has been set by the milled head.

No special transits were used on any of the tunnel work but the two that we had were carefully adjusted and the adjustments frequently checked.

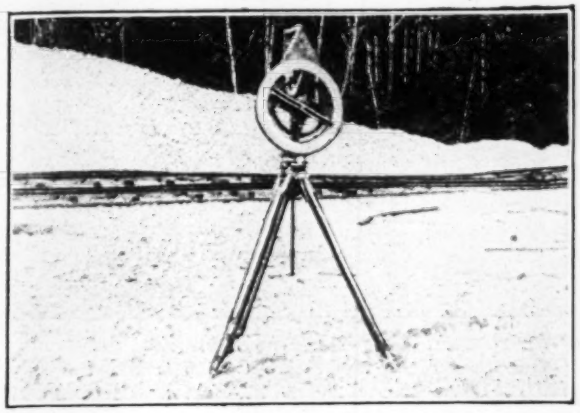
After the line had been thus established it was rectified by going over it again, using for the backsight a plumb bob hung from an extra tripod and for the foresight the target of a New York level rod. This level rod was rigidly supported in a horizontal position at right angles to the line about 3 ft. from the ground and directly over the hub on which the foresight point was to be set. The target was set by the transit and the rod reading recorded. From twenty to forty readings were taken on a single point, an equal number with the instrument direct and reversed. The average of all readings was then obtained and, the target being set on this average, the point was transferred to the stake by plumb bob.

This work was all done in the fall of 1922. Ordinary wooden hubs 2x2x18 in. and ordinary survey tacks were used. The tacks were pulled out and moved over on the hubs when necessary. After the line was satisfactorily established two of these points were replaced by monuments to carry the lire through the winter. One of these points was about 60 ft. west of the shaft, the other on high ground about 800 ft. still farther west. The latter point was preserved because a foresight within 800 ft. of the east portal could be seen from it but not from the monument near the shaft.

Monumenting—The monument near the shaft was made by digging a hole 4 ft. deep and about 1 ft. in

diameter, filling it with concrete and embedding in the concrete an iron bolt with a square head on which a prick punch hole was made. This monument was of somewhat smaller diameter at the bottom than at the top which raised a question as to whether it was not therefore liable to be heaved by frost. We were never able, however, to detect any evidence of its having moved. The other monument was of granite 12x12 in. x 3 ft. embedded in about 1 ft. of concrete. A copper bolt was cemented in a hole in the top with a prick punch hole in it. Both of these monuments were satisfactory.

Three foresight points were established, 1,400 ft.,



SUNFLOWER FOR CROSS-SECTIONING IN TUNNEL

3,400 ft., and 6,400 ft. east of the shaft, the latter point being only 800 ft. from the east portal. Permanent targets were erected over these points, which were chisel marks on three of the original line monuments. Two types of targets for permanent foresights were used, one a strip of black of varying widths on a white background, the other of alternate black and white squares. The latter type was found to be more satisfactory. The line on the surface was definitely established and monumented in the fall of 1922. It was rerun and checked in the summer of 1923 but was not changed.

Establishing Tunnel Alignment—The surface alignment was transferred to the tunnel through the shaft by means of two plumb wires. No. 8 piano wire was used. This was kept on two specially-designed reels which were firmly attached to the deck timbers of the shaft by means of lag screws. From the reel the wire ran over a grooved brass wheel which could be moved onto line by a slow motion screw and held in place by a lock nut. Each wire was kept taut by a 20-lb. weight swinging freely in a pail of water at the foot of the shaft. These weights were made of four angle irons riveted back to back. This shape was used to prevent spinning. Ordinary 14-qt. galvanized iron pails were used. These were fitted into home-made frames of shingle lath to which were also attached the light boxes and the scales by which two points on line were determined at the foot of the shaft. The light box was made by knocking the bottom out of an empty dynamite box thus making a square wooden frame. Slots were sawed in the top and bottom of this frame so that it could be fitted around the wire and a wooden crosspiece for attaching the scales was nailed from side to side.

Two 50-watt electric light bulbs were fitted to the sides of this frame just above the crosspiece to illuminate the scales and the inside of the frame was painted white to improve this illumination. A number of different scales were tried, the most satisfactory, or rather the least unsatisfactory, were of paper, divided in centimeters and millimeters, the centimeters being numbered. These scales, having black lines on a white background, were easily read but were not permanent as the water falling from the shaft wet and destroyed them. We had to use new scales nearly every time that the line was dropped. Two light boxes were used —one for each wire. Two scales were used to each box —one on each side of the crosspiece, four in all. The scales were attached to the crosspiece by thumb tacks and were protected by varnishing.

It was necessary to provide covers to fit over the pails to keep the water that was falling in the shaft from striking the water in them, for if this is not done the wires will jump and correct readings cannot be obtained.

Dropping Line to Tunnel—To drop line in the shaft the reels were fastened in place at the top of the shaft and the wires lowered with a light weight until their ends reached the bottom of the shaft. The 20-lb. weights were then attached, the pails filled with water and set in their frames and the wires with their weights raised or lowered until the weights swung freely in the water. The pails with their frames were moved about until the paper scales were directly behind the wires, as near them as possible without touching them, and approximately at right angles to the center line.

A transit was then set up on the monument just west of the shaft—about 50 ft. away from the nearer wire—a foresight was taken on the most distant target that could be seen—about 3,400 ft. east of the shaft—and checked on the nearer target, and the two wires very carefully set on line by means of the slow motion screws and clamp nuts. This work was done with one transit, but by two instrumentmen, with telescope both direct and reversed, and was continued until both men were satisfied that the wires were precisely set.

Two transits were then taken to the foot of the shaft and were set up, one in the east and one in the west tunnel, each about 30 ft. from the nearer wire. Each transit was set approximately on line and the reading of each wire on its scale was taken and recorded. The shaft was about 150 ft. deep and the wires hung nearly motionless by the time the transits were set up and we were ready to read them, so that by watching each wire for about a minute the center of its swing could be judged quite accurately. This reading was used only as a check on the final reading.

Taking Scale Readings—The wires were then set swinging and the readings on the scale at each end of the swing were called off by the instrumentman and recorded by an assistant. Readings were taken in sets of twenty. If the first two sets agreed and also agreed with the reading taken before the wires were set swinging the average of these two sets was taken as the correct point on the center line. If they did not agree readings in sets of twenty were continued until a satisfactory result was obtained.

As soon as the scale readings were determined for each wire the wires themselves were pulled to one side and fastened out of the line of sight. They were not used again. Each transit was then carefully wiggled onto line with its two scale readings. Lateral adjust-

ers, made by the instrumentmakers, were used in this and were found extremely useful.

The line in the tunnel was carried on brass scales set in the tunnel roof at right angles to the line. These scales were graduated for a length of half a foot in tenths and hundredths of feet. A rider with a vernier read to thousandths of feet and was provided with a hole opposite the zero of the vernier through which to thread a plumb bob string. These scales were set about 250 ft. apart along the tunnel, the first scale in each direction being about 50 ft. from the shaft. Three scales in each direction could be seen by the transits set up at the shaft and readings were taken by each transit on all six of these scales. In the first line droppings four readings direct and four reversed were taken on each scale, later these were reduced to three and sometimes two. Line was dropped, in all, seven times, and each time readings were obtained on all six scales. This gave a base line in the tunnel between 500 and 600 ft. long in each direction from the shaft.

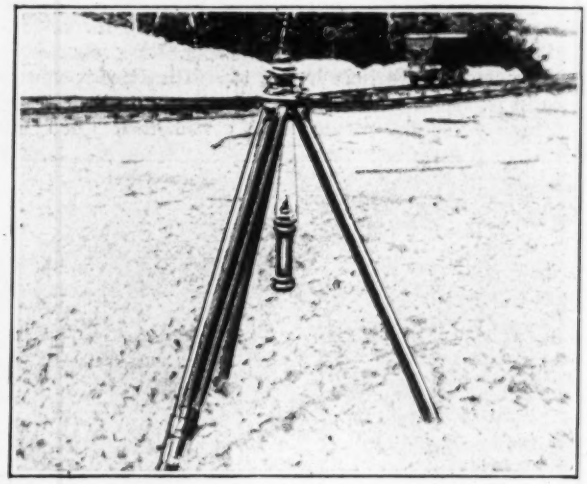
Securing Accurate Readings—In dropping line in the shaft every effort was made to interfere with the contractor's work as little as possible. Every two weeks the day and night shifts were changed about, so that on every other Sunday no regular work, either drilling or mucking, was going on. There was always plenty of very pressing work to be done on these off Sundays however; track laying, switch setting, pipe work, electric work, all sorts of things requiring some, though infrequent, use of the cages. We never dropped line except on the off Sundays and then never absolutely excluded the contractor's men from using the shaft; though on line dropping days, by previous arrangement with the superintendent, this use was reduced as much as possible. The hoist runners were warned and were careful to bring the cages to rest at the foot of the shaft with as little jarring as possible; and, though this use of the shaft was sometimes annoying, I do not believe that it interfered with the accuracy or precision of the work.

Smoke from the last blast, which occurred early Sunday morning, did interfere seriously at times; and we learned after one or two experiences that it was better not to make too early a start. Once around, setting the wires on top, setting up the transits, reading the wires, wiggling onto line and reading six scales both backward and forward, was a good short day's work and we found it much more satisfactory not to be hurried.

The most difficult part of the work was determining the correct readings on the paper scales at the foot of the shaft and getting the transits precisely on line with these readings. Plenty of time should be taken for this and it should be done with patience and care. The lateral adjusters are practically indispensable for the final wiggling in. In reading the paper scales the transits need not be accurately on line, but we found it a saving of time to have them nearly so.

Setting the wires at the top of the shaft must also be done with precision. This work is easier, however, as it is done in the open with a transit set up over a fixed point and using a fixed backsight. If the backsights are far enough away no extraordinary precautions need be taken to have them precisely on line. They should, however, be on the opposite side of the shaft from the monument over which the transit is set in order to obviate the necessity of plunging the transit before setting the wires.

Obtaining the readings on the brass scales in the roof of the tunnel after the transits are on line at the foot of the shaft is the easiest part of the whole procedure but consumes considerable time. At first we took



TUNNEL LAMP MADE FROM PIPE FITTINGS

Tripod has nothing to do with the lamp. Used merely as support for lamp while taking picture.

four readings direct and four reversed on each scale, moving the rider and plumb bob off line and resetting them each time. Later we reduced this to three and, in the case of the nearer scales, to two unless the readings did not check each other when additional readings were taken until a satisfactory result was obtained. When we first started we did not observe any particular order in which the scales were read but later we followed one procedure, starting with the most distant scale on the opposite side of the shaft and working to the most distant scale on the same side of the shaft, then back again to the first scale.

Tunnel Sights—Sights were taken in the tunnel by setting a plumb bob hung from the hole opposite the zero of the rider on the roof scale. This plumb bob was made visible by holding behind it a light box made from an empty dynamite box. The front of this box was a hinged frame over which was stretched yellow slicker cloth. The inside of the box was painted white and contained receptacles for two 100-watt electric lights connected to a 50-ft. lead which could be hooked up to a socket on the main lighting line. It would have been more convenient at times if these leads had been 75 ft. long.

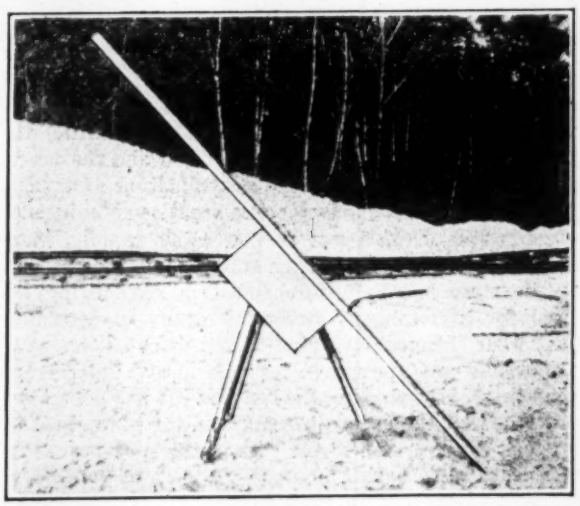
After the base line in the tunnel at the shaft had been established it was extended toward the headings by ordinary field methods. We did not use any elaborate system in this part of the work but ran the line in each direction in much the same way as we would have if it had been on the ground surface, using double centering and all ordinary precautions for accuracy. When the tunnel headings were within about 1,000 ft. of meeting, the line was rerun right from the start at the shaft. The two lines did not diverge greatly and were averaged for carrying the work ahead.

We had two systems of points in the tunnel—the roof plugs by which line and grade were given to the

contractor, and the brass scales on which our own alignment was carried.

Roof Plugs—Roof plugs were round wooden plugs about 2 in. in diameter and 5 in. long. We generally made them by sawing up birch saplings of about the right diameter, leaving the bark on. The field party spotted a point on the center line in the tunnel roof near enough to the heading to be reached by the drills as set up for drilling the face. The heading foreman then had a hole about 6 in. deep drilled for us at this point. The field party drove the roof plug into this hole and located the center line upon it. This center line point was preserved by driving in a tenpenny nail and a spad; the former for the use of the contractor, the latter for our own use. We found the spads the more convenient as a plumb bob string can be readily hung on them but the contractor's men were forever pulling them out. The tenpenny nail once in was in to stay, a man could hang his weight on it without budging it, and as the contractor did not use plumb bobs but a piece of wire fastened to the nail head everyone was satisfied.

When work on the tunnel excavation was first started we set these roof plugs about 40 ft. apart. This distance gradually lengthened until we were setting them from 80 to 100 ft. apart. The spacing of roof plugs depends a good deal upon the skill of the superintendent or the heading foreman in lining in his heading. The farther apart these plugs can be placed the better as



PROTRACTOR ROD FOR TAKING CROSS-SECTIONS
Board has protractor painted on it which does not show in photograph.

it saves the time of the field party, decreases inevitable interference with the contractor and gives a longer line between plugs with which to work. They must not be too far apart, however, or the excavation will get out of line or grade which would involve expensive trimming. All of the construction work, the excavation, the trimming and the concrete lining, has been located by the line carried on the roof plugs. This line was seldom shifted and then only in small amounts which would not affect the trimming. This was accomplished by carrying a secondary line on brass scales as near to the heading as possible by which the line of the roof plugs could be frequently checked and corrected.

The brass scales used were the same as those described under the line dropping, graduated for half a foot to read, with the vernier on the rider, to thousandths of a foot. When a scale was to be set we had three holes drilled in the tunnel roof in a line across the center line and approximately at right angles with it. Wooden plugs were driven in all three holes. The scale was rigidly fastened to the two outer plugs by means of small bolts passed through holes near the ends of the scale and the eyes of 3-in. screw eyes which had been screwed into the plugs. In the third plug a transit tack was driven and the distance from this tack to the zero of the scale was measured, with the idea of using this as a reference in case the brass scale should be hit or moved in any way. I believe this reference soon became a dead letter however.

Scales were set about 300 ft. apart, as double that distance was about as far as accurate sights could be taken in the tunnel. They were generally set after the tunnel heading had advanced about 500 ft. beyond them as they were liable to be hit by flying rocks if set any nearer. The line was carried ahead on these scales by double centering.

Running Out Curve—About 5,000 ft. west of the shaft an angle of about 14 deg. occurred in the line. The tunnel was driven around this angle on a 2-deg. curve giving a tangent length of 342 ft. and a length of curve of 681 ft. As the excavated tunnel was not much more than 9 ft. wide it was found that it would be necessary to turn at least two angles in taking the alignment around the curve. The distance on the ground surface from the shaft to the angle was obtained by precise chaining, as was also the distance in the tunnel from the shaft to the point of tangency. The tangent line was extended back from the point of tangency as far as possible until there was just room to set up a transit on line inside the tunnel. Here a brass scale was set in the roof and its distance from the point of tangency measured by precise chaining. No more work on extending the alignment around the curve was done until the line had been definitely established in its entirety from the shaft up to and including this last scale; that is until we had a scale reading on every scale that we were satisfied would not be changed.

A second scale was then set in the side of the tunnel roof as far along the curve as we could see from the first scale, care being taken not to have the line of sight pass too closely to the opposite wall. The distance between the two scales was measured by precise chaining, an arbitrary scale reading on the second scale was selected and the angle obtained by repeated readings. This angle was read in all thirty times. The angle and distance required for reaching the point of curve were then calculated and a third scale set as nearly as possible on this distance. After the third scale was set its actual distance from the second scale was measured and a calculation made for the angle that should be turned at the second scale to give the point on the third scale at which the tunnel center line crossed it. With the transit set up at the second scale this angle was turned and a plumb bob set on the third scale. The reading on the scale was noted, then the angle was multiplied thirty times. The difference between the multiplied angle and the calculated one, with the distance between scales, gave data for calculating a correction to the original reading on the third scale. For turning at the third scale onto the forward tangent

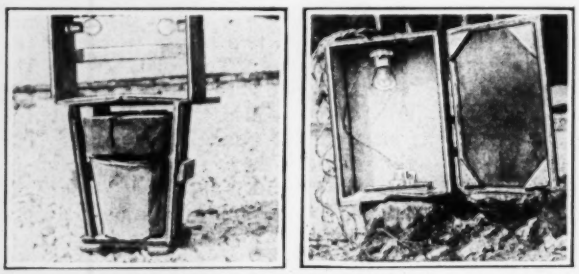
the angle was set and the scale reading was corrected.

Precise Chaining—The only precise chaining that we did was between the shaft and the angle. No other chaining of any sort was done on the surface as the old property monuments had already been stationed before we came on the job. Ordinarily chaining for stationing cross-sections and for grades was done in the tunnel.

For precise work we had a 100-ft. steel tape that had been compared with the city standard and for which the corrections for sag had been determined. Transit tripods were used with aluminum caps on which a pencil mark was made at the 100 ft. end of the tape when under a 15-lb. pull, levels being taken on the tripod tops the horizontal distance was calculated and corrected for temperature and sag.

Levels were run into the tunnel at each portal as they would be on the surface. At the shaft a bench was established at the bottom by hanging two 100-ft. steel tapes tied together from a beam just above the ground surface and taking readings on them simultaneously with two levels, one at the surface and the other in the tunnel. This was done three times by different parties on different dates.

Bench marks were established at intervals of about 750 ft. They were made of short pieces of drill steel cemented into holes drilled in the side of the tunnel.



LEFT—SCALE BOX AND PAIL; RIGHT—LIGHT BOX

The tunnel to the east of the shaft was about 6,600 ft. long, that from the east portal about 600 ft. The headings met with an error of 0.18 ft. in alignment and of 0.018 ft. in level. The tunnel to the west of the shaft was about 6,800 ft. long and contained a 2-deg. curve 681 ft. long, that from the west portal about 3,600 ft. These headings met with an error of 0.4 ft. in alignment and of 0.06 ft. in level.

Cross-sections were taken in the tunnel at intervals of 10 ft. Some of these were taken by use of a sunflower machine, others by a home-made affair that we called a protractor rod. This consisted of a rod 6 ft. long, graduated to tenths of feet, to which was attached a light wooden protractor, graduated in half a circle to degrees. A plumb bob fastened at the center of this protractor gave the inclination of the rod from the vertical. This machine is both handier and more accurate than the sunflower. Both machines were centered by means of lights hung from the roof plugs in much the same manner in which the contractor spotted the point from which to paint his heading.

The contractor generally used candles for his lights but for our own use we found it more convenient and more accurate to use home-made lamps made from pipe fittings. These lamps consisted of pieces of 2-in. pipe about 6 in. long, threaded at both ends. A cap was screwed to the lower end and to the upper a sleeve, a reducer and a plug. A small hole was bored through the plug into which wicking was fitted, and the whole affair was suspended on a short piece of light chain. These lamps burned kerosene oil.

A number of methods were tried for marking trimming. The quickest was by means of a light wooden templet built for a line 12 in. inside the trimming line. This was plumbed by a level bubble fastened to one of the lower braces and centered by a wooden leg that fitted over a shoulder of the concrete wall footings. This templet was also used before the footings were in by setting braces of 2x4-in. timber across the tunnel about 30 ft. apart and stretching a line between them, the line being set on the tunnel center line and at a predetermined grade. A stick with a shoulder 12 in. from the end was used with the templet.

New Jersey Engineers Study Shore Erosion and Protection

State Board of Commerce and Navigation in Second Report Detail Extensive Studies and Outline Recommendations for Shore Protection

IN A report just issued, but dated 1924, the Board of Commerce and Navigation of New Jersey has made a weighty contribution to the theory and practice of shore protection. New Jersey has a very extended ocean frontage and that frontage is for the most part a valuable asset because of the summer residences thereon. It is, moreover, for most of its length a flat beach shore, with numerous inlets and offshore bars, the kind of shore readily attacked by the force of wind and waves. The state some years ago recognized the value of these shores and the board representing the state instituted a study of their erosion and the necessary protection thereof. The net valuation of taxable property of the New Jersey ocean front community now exceeds $500,000,000 and is increasing rapidly, more rapidly than the values in the state as a whole.

The state has been forehanded in recognizing the need for a continuous systematic study to determine just what changes have been taking place on the ocean front and what measures may be most effective and economical in protecting the beaches. It has recognized the fact that the great divergence in the views held by various engineers as to the best methods of protecting the coast rests primarily upon the lack of continuous study and represents confusion based on inadequate data. The board in 1921, therefore, established an engineering advisory board to carry out the studies it recognized to be necessary, the line of inquiry practically coinciding with the procedure recommended to the British Royal Commission, which conducted an elaborate investigation in the years 1906 to 1911. The major burden of the work devolved upon the following members of the engineering Advisory Board: The late B. F. Cresson, Jr., consulting engineer of the Board of Commerce and Navigation, who served as chairman until his death in 1923; Commander R. S. Patton, U. S. Coast and Geodetic Survey; Col. Earl I. Brown, Corps of Engineers, U. S. Army; Charles W. Staniford, consulting engineer of the Board of Commerce and Navigation; and Victor Gelineau, director and chief engineer of the Board of Commerce and Navigation, who succeeded Mr. Cresson as chairman.

The work has continued since 1921 when the first field parties undertook detailed surveys. Soon thereafter a report dated 1922 was issued outlining the preliminary surveys. These surveys have been repeated, particularly in the vicinity of various coast protection structures, at times chosen to indicate accurately the effect of storms in various quarters and of prolonged periods of offshore and onshore winds, to indicate the respective effect of these factors in modifying the line and contour of the beaches. Much valuable information has been collected from which deductions based upon sound data can be drawn. This study is being broadened to include hydraulics of inlets, velocity and height and other characteristics of ocean waves under varying conditions, the direction of littoral drift under varying conditions, and the depths to which severe storms are effective in modifying the ocean bed.

The latest report, 1924, contains in addition to a brief chapter on the general principles of coast protection a detailed description of all the coast protection work on the coast of New Jersey, which has been probably more considerable than anywhere else in the United States, and a number of conclusions and recommendations.

The latter are so important that they are appended hereto:

Definitions—In this report the word "jetty" signifies a massive structure for protection of the coast at particularly important or vulnerable points. The word "groin" is used for a lighter structure protecting a short length of the beach.

Walls generally parallel to the beach are called sea walls if built of concrete or rock, bulkheads if built of piles and timber. The latter may or may not be protected by loose rock at the base.

Conclusions and Recommendations—(1) Neither bulkheads nor groins can be recommended for use separately except in special cases.

(2) The use of concrete for bulkheads is not recommended except for those heavier and more permanent types which may be classed as sea walls. Its use is highly hazardous where any serious settlement may be expected.

(3) Timber bulkheads should always be provided with rock protection. The rock should be of large size.

(4) The construction of shore bulkheads and sea walls seaward of ordinary high water line is to be permitted only when absolutely necessary for the immediate protection of existing structures such as buildings, roadways, etc. When their construction is unavoidable, they should be supplemented by suitable groins.

(5) The distance between groins requires for its determination a due consideration of many factors including the slope of the beach, height of waves, distance to offshore bar, proximity of ocean inlets, etc. If the space between groins is too great, the frontage to the leeward of the groins will be left without protection. If this space is insufficient, scour may result from back-wash and interference of the two groins. In general, groins should be spaced from one to one and one-half times their length.

(6) Groins must always be securely and tightly connected to a bulkhead or extend well inshore to points beyond the reach of the highest waves. Disaster will almost certainly follow if the water is permitted to pass the inshore end of the groins. Any breach or poor connection between a groin and a bulkhead on a sandy beach is almost certain to nullify the effect of the structures.

(7) In groins sheetpiles should have a minimum penetration of 10 ft. Even this will be inadequate in some situations. The groins must be of tight construction, preferably of tongued-and-grooved sheetpiling well lined and braced by wales and piles. The piles must have a penetration of at least 25 ft. and the timber should generally be treated with creosote. All bolts, rods, spikes, etc., shall be galvanized.

The rock should be of large size. Stone less than 100 lb. should not be used. Even rock of such small units as 100 lb. is of very slight value. Where the exposure is severe, nothing less than one-half ton should be considered, and approximately 75 per cent of the rock should be of units weighing two to six tons or more. In general, rock should have a least dimension at least equal to one-third its largest dimension.

The incorporation of a sand-tight core in groins is essential. This should be ordinarily of timber piles and sheetpiling. It may be of rock where sufficient material is used, in the class of large structures. The core must be a substantial structure. If of timber it must be supported by piling or by rock or by both.

(8) Groins or other structures designed to gather large areas of beach should be permitted only for special reasons and after careful study of the probable effect upon adjacent communities. What is to be sought is coast protection and coast extension. Extension at one place is likely to be accompanied by recession at points in the vicinity.

(9) The height and slope of the groin with respect to the profile of the beach depends upon many factors. Structures of the type found to be necessary on the steep beaches of northern New Jersey would be needlessly expensive in many sections of the southern New Jersey beaches where the profile is much flatter and where greater fluctuation of the shore line may be permitted.

If the beach has been seriously lowered and the slope permits, it may be most economical to build a low structure, that is, some 3 ft. above the normal profile of the beach, but so design the core as to permit the addition of wales and sheeting to obtain higher level of the beach when the low jetties attain their maximum effect.

(10) The construction of curved groins or jetties should be permitted only after thorough investigation. There is no evidence that curved groins offer any greater promise of success than straight groins.

(11) Coast protective works must be adequately maintained. The tendency has been to pay little or no attention to maintenance until serious damage occurs. Where state aid is given to protect the shores, provision should be made for the maintenance of such works in good repair.

Municipalities fronting on the ocean should adopt and maintain general programs for the adequate protection of their ocean front. Perhaps the best means to accomplish this would be the establishment of a fund into which moneys would be paid every year, the expenditures to be made therefrom as required. The almost universal tendency is to view with indifference the inroads of the ocean, making no effort to hold the beach until valuable structures are actually attacked.

(12) The growth of sand dunes along the coast should be encouraged and promoted. Unfortunately, in New Jersey the tendency has been to level the sand dunes as construction of roads and dwellings progresses. Public authorities should discourage the removal of sand from the beaches where this sand is used for construction purposes or for filling of low lands. The artificial removal of sand from the New Jersey beaches is a serious evil.

The best means of encouraging the growth of sand dunes is to plant beach-building vegetation, such as sea oats, sea wheat and other beach plants. In some places, particularly low spots, fences may be employed to gather the drifting sand.

(13) There is no evidence to justify the contention that the protection of the beaches can well be attained by means of heavy key work of great extent and massiveness, such as heavy outshore breakwaters or current deflectors.

(14) To control the location and navigable depth of inlets, tight jetties are necessary, and in the case of many inlets two parallel jetties are needed to carry the current into deep water.

(15) Twin jetties at inlets possess a superiority over a single jetty, whether straight or curved, and may be used with more confidence of results.

(16) In length jetties should always extend from high water line, or from a proper bulkhead, outward to such distances as may be required by the problem at hand. For navigation purposes they must necessarily extend out sufficiently far to obtain the low water depth sought. For fixation of location of inlets and for beach protection purposes an extension to or only slightly beyond low water mark is necessary. It should be borne in mind in all cases that long jetties may temporarily cut off from the leeward beach the supply of drifting sand upon which its maintenance in normal conditions depends.

(17) The northern beaches of New Jersey, that is from the vicinity of Long Branch northward, are relatively steep. This is a situation which requires the application of substantial structures, that is heavy rock breakwater jetties. Light wooden structures, not adequately supported with heavy rock, will not serve on this frontage.

The southern beaches are less steep, and here the construction of such heavy works is not ordinarily justified from the standpoint of economy, except in the vicinity of inlets.

(18) Every section of beach presents a problem with its own peculiarities. It is therefore impossible to give precise rules that can be applied offhand to particular localities; but the type of structures discussed and recommended in this report have proved their effectiveness as shown by the results obtained during the past few years, and consequently much of the confusion and uncertainty on this subject has been removed.

(19) For breakwater jetties of magnitude the tight sheetpile core type surrounded by large rock is recommended. Dimensions of the jetty should be suitable for the location.

(20) In extensive, or key construction of magnitude, as distinguished from local protection on the beaches, no small stone should be used. Contracts should call for large stone, say 85 per cent of three tons and upward, with no stone of less than one ton. In general, rock should have least dimension at least equal to one-third of its major dimension.

(21) Preparations for jetty contracts where rock is to be used should include, in addition to soundings, borings to locate a hard bottom, if one exists.

(22) Where hard or firm bottom exists, and a core wall is to be used, plans should call for piles and sheetpiles to extend well into it. Where no hard bottom is found, then the longest piles and sheetpiles should be used within reasonable expense.

Technical Papers Before Port Authorities

ONE afternoon of the meeting of the American Association of Port Authorities in New York, the week of Sept. 28–Oct. 1, was devoted to the presentation and discussion of technical papers. Among them the following were of special interest:

Brysson Cunningham, the English authority on port development, compared the method of port administration in other countries with the United States. State management is principally in evidence in France and Italy, autonomous management with a large elective and small nominated element in Great Britain with considerable representation of the railway element at the autonomous ports, and in North America the control is a combination of state and municipal management with rare entry of any private interests. In Great Britain, however, the ports are as well self-supporting, whereas in North America the state has generally to grant large subsidies. In conclusion, Mr. Cunningham said: "Reviewing the foregoing systems it may be said that while state administration affords a stable and secure basis for the financial welfare of a port, it is not altogether free from the evils of political intervention. Public opinion in Great Britain, at any rate, is critical in regard to state and bureaucratic administration in that, with certain exceptions, it exhibits a tendency to repress enterprise and activity and to become more or less subject to official routine and conservatism. Railway management is frankly undertaken in the interest of the railway system and although this is in itself not a fundamental objection, yet both in this case and in the case of municipal management there is certainly to be feared an outlook which is restricted to the immediate advantage of the railway or the municipality concerned. Particularly is this so in the case of the municipality which may wish from the popular point of view to limit the expenditure and activities of the port to its own area and not to cater for the larger district which lies outside the municipal boundaries. Company management suffers from the limitation of its resources and in the past such managements have been found incapable of providing adequate funds for the development of their ports."

L. W. Baldwin, president of the Missouri Pacific Railroad Co., in a paper entitled "Co-ordination of Rail and Water Facilities," argued for a better feeling between the two elements in transportation—that is, the railways and the waterways—particularly in the development of their joint terminals, but insisted that the railways be represented in any port control.

The paper by William F. Williams, Massachusetts commissioner of public works, describing the extended use of the motor truck in serving the Commonwealth pier in the Port of Boston, brought forth considerable discussion as to the area of activity of the motor truck in serving a port. Elihu C. Church, transportation engineer of the Port of New York Authority, introduced a note conflicting with some of the railway authorities present in predicting that the use of the motor truck would be extended to longer distances rather than restricted as the railway authorities contended. His prophecy was that within ten years trunk-line motor highways would be built between important cities by private corporations, much as railways were built in the early days, and that these would be used exclusively for freight transportation. E. B. Hadley, chief engineer of the Missouri Pacific, introduced the railway view when he said that he believed that his road suffered from the unfair competition by motor truck as the railroad was one of the heaviest payers of taxes to build and maintain highways, whereas the trucks which use the highways to compete with the railroads did not contribute either to their first construction or maintenance. The same criticism applied to competing waterway lines.

Technical papers consisted of one by H. W. Frith, acting chief engineer of the Vancouver Harbour Commissioners, which described the so-called "grain jetty" in the Port of Vancouver, which is an overhead steel frame bridge resting on concrete and timber cribs on 125-ft. centers, extending out into the harbor on the other side of the slip which serves the large grain pier. E. F. Cykler, of Los Angeles, described the so-called "Duocrete Piling," that is, concrete piling used in the harbor of Los Angeles in which the more or less porous concrete has its voids filled by a plastic waterproof substance which is in itself inert and unaffected chemically by sea water. Other papers related to methods of selling a port, description of the harbor of New York, ship and cargo salvage operations in harbors, and rail rates as a factor in port development.

Many Defective Highway Bridges in Virginia

Unsatisfactory bridge conditions are revealed by a survey of the bridges on the state highway system of Virginia, according to H. G. Shirley, chairman of the state highway commission. Of the 59,000 miles of road in the state, only 4,900, or 8 per cent, are included in the state highway system. On these 4,900 miles there are 719 bridges more than 20 ft. long and 32 fords. Only 159 are adequate in width and load capacity for present and prospective traffic, while 415 are either too narrow or are unsafe for heavy traffic. Immediate replacement is required for 218 narrow or structurally dangerous bridges.

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Underpass Shifted Without Interruption to Rail or Highway Traffic

ON THE line of the Boston & Albany R.R. near North Wilbraham, Mass., one of the trunk-line highways underpasses the railroad. Until last year the underpass was one of 90 deg.—that is, the axis of the road at the underpass was perpendicular to the center line of the railroad track. Inasmuch as the highway practically paralleled the railroad at this point, this meant a very sharp reverse curve for vehicular traffic. In order to secure longer visibility and reduce accident possibilities, a new underpass was built. As neither railroad nor vehicular traffic could be interfered with, the situation presented rather unusual difficulties. In

UNDERPASS BUILT WITHOUT TRAFFIC DELAYS

Above—Railroad tracks in shifted position.
Below—New underpass on 40-deg. angle. Old underpass at 90 deg. at left.

effect, however, the problem was solved by spreading the railroad tracks to allow for excavation for the new underpass between them and by allowing the old underpass to be used until a new one had been put in shape for service.

The railroad tracks were first shifted about 500 ft. each side of the underpass, each track being shifted 22 ft. outside its original position, giving a space 56 ft. between center lines. The new underpass was constructed 130 ft. east of the old one. When the new underpass had been completed to the point where the concrete-encased steel girders were set on their abutments, the tracks were shifted back into their regular alignment, after which the wingwalls were constructed. Railroad traffic was not diverted from the regular line until the shifted tracks had been entirely ballasted. As the tracks are double along this stretch of railroad, this made in effect double turnouts for each track.

Cutting Piling Under Water—Review of Various Methods

BY SAMUEL P. BAIRD
Engineer and Contractor, Columbus, Ohio

WHERE piling has to be cut under water at a specified elevation and with flat tops there does not seem to be any other way than by sawing. Where the cut is not much below the water level, say 2 ft., it is possible to do it by hand. For greater depths circular saws on vertical arbors or shafts are necessary. The circular saws are mounted in a frame, which in turn can be carried by the piling either before or after the cut is made or by a boat floating in the water. Other ways of cutting where it is permissible to leave a ragged top are by use of dynamite and by cutting with a chain.

Where it is possible to cut by hand sawing, it is usual to use four men, two guiding the saw and helping as much as possible. These men of necessity must be in the water. The other two men are above water and pulling on the saw alternately by means of ropes. This method can be used where there are few piles to be cut. When the cut is to be made at a fixed elevation guide strips are spiked to the piling and the saw run between the strips.

If there is much piling to be cut a circular saw on a vertical shaft and driven by power is an economical method especially where level flat tops are required. It is the usual practice to mount the saw arbor in a frame with means for vertical adjustment as well as for feeding the saw to the pile.

If the saw rig is mounted on a boat it is necessary to use spuds to support and steady the boat as wind, waves and any movement of the boat crew will raise, lower or tilt the boat and this affects the saw, which, if the cut has been started, always leads to trouble. By all means plan to use spuds.

A method has been tried for having the saw mounted on a quill or hollow shaft which can slide on the vertical shaft. This makes the saw independent of the movement of the boat. For the successful operation of a circular saw, plan to use either a boat with spuds or the saw frame carried on skids which in turn are carried by the piling. Use a saw with plenty of clearance. Sometimes a saw is mounted as a wobbler. This cuts an exceedingly wide kerf. Don't try to feed too fast.

Where it is only necessary to cut the piling at the river bed contour some have had success in using dynamite. A very successful way is to use some old 1¼-in. hose into which the dynamite is packed with the necessary electric exploders. The closer the dynamite is to the piling the more effective. The hose is made in the form of a ring surrounding the pile. Poles are used to push the hose down the pile to the river bottom. Lash or nail the poles to the piling and when every one is in the clear fire the charge. Use plenty of dynamite of at least 40 per cent strength, though 60 per cent is much more effective.

My first experience with cutting piling with a chain gave very satisfactory results. Use about 100 ft. of ⅜-in. or ½-in. chain and to each end attach a wire line leading to one drum of a double-drum hoister. Pull alternately on the two drums keeping a strain on the drum paying out by using the brake. The chain is just dropped over the pile and falls to the river bed—a half turn is enough. A round turn is too much with most wood. Sand shoveled into the water so as to feed into the cut by the chain is helpful. A chain made of square metal instead of round seems to cut faster.

An idea has come to me which I think would be worth while trying if a number of piles are to be cut under water at the ground level. This idea suggests the use of a number of malleable-iron or cast-steel washer-like castings having teeth on the edge and a hub on one side to act as a spacer. The pieces would have a hole through which to thread a flexible wire rope, say ⅝ in. Socket this rope at both ends as snugly as possible to the castings, making it as if it were a flexible rat-tail file 1½ in. in diameter with teeth ¼ in. deep. Then proceed as directed for cutting with a chain. This should cut almost as fast as a circular saw. Ordinarily cold or hot-pressed square blank nuts strung on a wire rope with something between to act as spacers to give the corners a chance to dig in, would be a cheap way to test the flexible rat-tail file method of cutting.

Precast Risers Used in Building Reinforced-Concrete Bleachers

By D. Graham Moon
Chief Engineer, Marinette & Menominee Paper Co., Marinette, Wis.

In the construction of bleachers for Lauerman Field, the athletic field for a high school at Marinette, Wis., unusual methods were used in the construction of the risers and treads, the former being precast pieces. The funds for the field were raised by public subscription, and the cost of constructing the bleachers was donated by Lauerman Bros. of Marinette.

After excavating for the footings, the bents were first poured, each in one continuous operation, slots and tierods being left for the lateral beams at the top. In these bents slots were left to take the precast risers. These risers were then set into place with a ginpole and the seats poured between them with removable forms bolted to the risers. This method disposed of the necessity of any supporting work between bents for pouring the risers and seats.

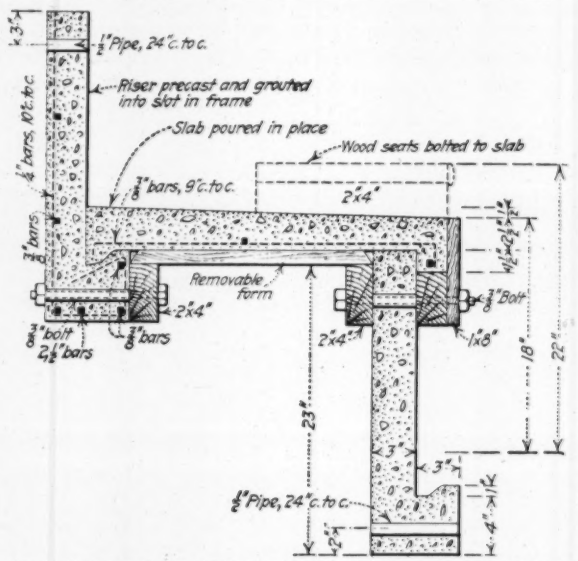
The risers were poured in molds built on a platform with a 3-in. strip for one edge and a 6-in. strip for the other, with a specially-shaped strip tacked across to form the two half-rounds of the lip. This left the face of the riser exposed to make possible smooth finishing with a hand trowel. In these risers at 2-ft. centers were left pieces of ½-in. pipe to which were subsequently bolted the removable forms for the seat section. It will be noted that the leg at the foot of the riser was molded in such a way that when the seat was poured it gave some anchorage into the leg, and was also tied into the next riser by the slight overhang at the end of the seat. In setting the risers on the bents they were bedded into a cement mortar setting and leveled up. The whole, when completed, gave a very finished appearance.

Drainage holes were left through the seat slab at frequent intervals and wooden seats were attached to the concrete slab by leaving bolts embedded in the slab.

Twelve sections, or a total of thirteen bents, were constructed, giving a total seating capacity of over 2,000.

From Job and Office

Hints that Cut Cost and Time



SEAT DETAILS OF REINFORCED-CONCRETE BLEACHERS

Steam and Electric Shovels in Open Mine Excavation

Two electric power shovels of the railroad type have been in operation for about a year on the open pit work of the Utah Copper Co., at Bingham, Utah. According to a paper by H. C. Goodrich, chief engineer of the company, in *Mining and Metallurgy*, the official publication of the American Institute of Mining and Metallurgical Engineers, this departure from the previous practice involving the use of the railroad type of steam shovel was justified economically, since the cost involved (return on investment plus cost of operation) appeared to be lower than that for any other equipment for open-pit excavation, so far as this particular property was concerned. An abstract of this paper is given below.

At Bingham the altitude and latitude contribute to a severity of weather which, for the larger part of the year, seriously hampers the coaling, water and other operations of steam equipment. The elimination of these operations, with attendant delays, is a factor of no mean consideration in making the electric operation more favorable. Other loca-

DELAYS WITH STEAM AND ELECTRIC SHOVELS

Steam: 22 Months	Per Cent of Time Lost	Electric: 12 Months	Per Cent of Time Lost
Waiting for coal	0.15	Transformer or motor generator trouble..	0.65
Waiting for water...	1.58	Motor trouble	1.83
Waiting for steam...	1.37	Control trouble	.62
Taking water	0.32	Other electric trouble	2.13
Taking coal	3.52	Power interruptions .	1.73
Washing boilers ..	2.85		
Cleaning fires	0.12	Total	6.96
Total	9.91		

From Job and Office

For Contractor and Engineer

tions may have conditions more favorable to steam operation. Sufficient power was available close to the mine.

Comparative costs of operation cannot be given, as costs of fuel, power and overhead vary, while experience with the electric shovels is of but one year's duration. A comparison based on ability to perform work is not of particular value on account of such erratic factors as waiting on cars and hard and soft digging; so that during some months the steam shovel will load more per shovel shift than the electrics, while in other months the latter may have the higher record. In regard to delays, however, it has been demonstrated that those incident to electric operation are 70.23 per cent of those incident to steam operation.

Of the two electric shovels, one uses alternating current and the other direct current, but it is not yet possible to determine the all-round desirability of either one. Concerning fuel and power consumption, experience at the Bingham mine indicates that the power or kw.-hr. consumption per cubic yard of material excavated is about 10 per cent greater with the alternating current machine. Steam shovels average 0.0035-ton of coal per cubic yard of material excavated.

The program of betterment of the Utah copper mine anticipates the complete electrification of all shovels.

Depreciation on Slip-Joint Protected Steel Pipe

By E. Court Faton
Irrigation Engineer Department of Public Works, State of California, Sacramento

A GROWING number of California irrigation districts are adopting the pipe distribution system for irrigation. The installation of such a system is costly, and is limited to areas intensively developed to fruit production and where, due to its cost, the conservation of water is essential. Two irrigation districts in the San Joaquin Valley within twelve miles of each other—the Lindsay Strathmore and Terra Bella—were among the first to construct extensive systems of this sort, which included metering.

These districts are planted principally to citrus fruits, and use about 1½ acre-ft. of water per acre per year with costs to the grower ranging from $25 to $30 per acre per year, these costs including bond interest and operating costs. Both districts pump from wells with lifts ranging to 285 ft. or more.

The combined area of the two districts is 27,570 acres and the cost of the 180 miles total of pipe installed was $981,000, or an average of $5,450 per mile which

Comparative Strength of Various Sections of Rolled Steel Beams

By A. W. A. Eden
Fagan Iron Works, Jersey City, N. J.

THE accompanying tabulation, which gives the section moduli of American standard beams and of Bethlehem beams and girder beams has been found very useful.

The 1925 edition of the Bethlehem "Condensed Catalogue" shows so many alterations and additions to those shown in the 1909 and 1911 editions that some such complete tabulation is essential when designs must be arranged so as to use available stock or expedite deliveries from mill rollings.

It is probable that other sections may be put on the market by the U. S. Steel Corporation when their new mill at Homestead is completed, but it is likely that the American standard sections will still remain the basis of all comparisons; and until there actually are material additions to the line of beams shown in this table, it may prove serviceable to many readers, especially those who are not in constant touch with developments in structural mills and fabricating shops.

For those who prefer it, a similar tabulation may be made for resisting moments instead of section moduli.

SECTION MODULI OF BETHLEHEM AND STANDARD BEAMS

Beth. Girders			Beth. Beams			Am. Std. Beams			Beth. Girders			Beth. Beams			Am. Std. Beams		
D	Wt.	S. M.	D	Wt.	S. M.	D	Wt.	S. M.	D	Wt.	S. M.	D	Wt.	S. M.	D	Wt.	S. M.
30	200.0	607.5	..	.....	.....	..	.....	.....	..	.....	.....	20	62.0	122.4	20	75.0	126.3
	190.0	576.7	..	.....	.....	..	.....	.....								70.0	121.4
	181.0	547.6	..	.....	.....	..	.....	.....	15	74.0	117.8	18	64.5	117.3	*21	60.4	117.7
28	175.0	497.1	..	.....	.....	..	.....	.....				20	59.5	117.0	20	65.4	116.9
	165.0	469.9	..	.....	.....	..	.....	.....	..	69.0	108.4	15	71.5	105.3	15	81.3	106.1
26	160.0	427.0	..	.....	.....	..	.....	.....							18	70.0	101.9
	151.0	402.9	..	.....	.....	..	.....	.....	12	76.5	97.2	18	54.5	98.1	..	65.0	97.5
	144.0	381.0	..	.....	.....	..	.....	.....					52.0	93.5		60.0	93.1
24	149.0	369.1	30	129.0	369.6	..	.....	.....	..	70.5	89.7	..			15	75.0	91.6
	141.0	347.9	..	121.0	347.6	..	.....	.....	..	.....	.....		49.0	88.4	18	54.7	88.4
	133.0	327.7	..	115.0	327.1	..	.....	.....	..	.....	.....	15	59.5	88.4	15	70.0	87.9
	129.0	318.8				..	.....	.....	..	.....	.....					65.0	84.3
20	149.0	308.8	28	113.0	304.8	..	.....	.....	..	66.0	82.8	..			*18	48.2	81.9
24	121.0	298.8	..			..	.....	.....	..	61.0	79.2	..	54.5	81.3	15	60.8	81.2
20	142.0	293.2				..	.....	.....	..	55.5	72.0	..	50.5	74.7	..	55.0	67.8
24	114.0	279.8	28	106.0	285.3	..	.....	.....	..	51.5	66.6	..	42.5	64.5	..	50.0	64.2
20	135.0	277.7		100.0	267.1	..	.....	.....				..	40.0	61.0	..	45.0	60.5
..	120.0	249.1	24	104.5	246.4	24	120.0	250.9				..	38.5	59.0	..	42.9	58.9
..	.....	.....	26	98.0	245.1	..	115.0	245.0	10	50.0	54.4	..	.....	.....	*	37.3	54.1
							110.0	239.1									
..	113.0	234.0	24	99.5	234.3	..	105.9	234.3	..	.....	.....	..	.....	.....	12	55.0	53.2
			26	91.0	227.9				..	44.5	48.9	..	.....	.....	..	50.0	50.3
15	147.0	220.4	24	95.5	222.8				..	41.5	45.2				..	45.0	47.3
20	107.0	219.7				*27	90.0	219.1	9	43.5	42.5	12	36.5	44.9	..	40.8	44.8
15	141.0	210.4	26	85.5	211.9				..	38.5	37.9		31.0	38.5	..	35.0	37.8
	135.0	200.4	24	84.5	198.3	24	100.0	197.6	..	36.0	35.5	..	28.5	36.0	..	31.8	36.0
18	100.0	190.5	..			..	95.0	191.8							*	27.9	33.2
	93.0	177.0	..	79.5	186.4	..	90.0	185.8	8	37.0	32.3				10	40.0	31.6
			..			..	85.0	180.0	..	33.0	28.6				..	35.0	29.2
15	111.0	172.8	..	73.5	173.9	..	79.9	173.9	..	31.0	26.7	10	26.0	27.1	..	30.0	26.7
18	87.5	164.7	..			20	100.0	164.8	..	.....	.....				9	35.0	24.7
15	105.0	162.4	..			*24	74.2	162.5	..	.....	.....	..	23.5	24.4	10	25.4	24.4
			..			20	95.0	160.0	..	.....	.....				*	22.4	22.7
			20	78.0	156.1				..	.....	.....				9	30.0	22.5
..	99.0	152.5	22	71.5	154.2	..	90.0	155.0	..	.....	.....	9	22.0	20.5	..	25.0	20.3
..	.....	.....		68.5	147.7	..	85.0	150.2	..	.....	.....	..	20.5	19.0	..	21.8	18.9
..	.....	.....	20	73.0	146.8	..	81.4	146.6	..	.....	.....				8	25.5	17.0
..	.....	.....	22	65.5	140.9	18	90.0	139.6	..	.....	.....				..	23.0	16.0
..	.....	.....	18	74.0	136.6	..	85.0	135.2	..	.....	.....	8	19.0	15.6	..	20.5	15.1
..	80.5	128.1	20	64.5	127.6	..	80.0	130.8	..	.....	.....				*	17.5	14.6
..	.....	.....	18	69.0	126.9	..	75.6	126.9	..	.....	.....	..	17.5	14.2	..	18.4	14.2

*Carnegie Supplementary Beams.

included all pipes, fittings, services, valves, labor of installation, excavation, contractors' profit, etc. The cost of the pipe alone installed but without fittings, services, etc., but including trenching and backfill, was about $4,650 per mile.

The pipe used was slip-joint light riveted-steel pipe protected by dipping and covered with a high-grade roofing paper lapped spirally under tension. Pipe sizes range from 4-in. diameter No. 16 gage to 36-in. diameter No. 10 gage. The grade of dip employed was specified as to melting point and penetration and the pipe covering was of a high grade. Careful inspection was given to the manufacture and laying. Contract prices included the maintenance of the pipe for one year in each case and the repair of leaks during that period. The location is one where ordinary dipped unprotected pipe had a very short life.

The installations were both completed in 1918. The annual costs of maintenance and repair of leaks for the six years 1919 to 1924: average for the two districts $11.60 per mile of pipe per year, the costs for the separate districts being $11.08 and $12.15 per year.

A number of leaks show up with the approach of cold weather due to contraction of the slip joints, others occur where abrasions due to a rock left in the trench has broken the protective covering, indicating the necessity for exceptional care in handling and bedding of pipes. Pipes are laid with a 2-ft. cover of earth. A number of holes were recently dug to examine the protective covering and it was found that the mica coating applied to prevent adhesion of the soil to the covering was still present. The pipes were installed under the supervision of the writer as resident engineer.

Protecting Highway Cuts Against Flow Sand

ON State Trunk Line 14 in Roscommon County, Michigan, there is a piece of road which has been constructed through a portion of the forest reserve of the state. The soil throughout this section is made up largely of sand and gravel. Some means of bank protection in cuts had to be devised so that the sand would not be carried away by wind storms. Due to the fact that sod could not be obtained to sod the slopes (though it is doubtful sod would have lived even if obtainable) and also to the fact that wild deer which roam this reserve ate up such sodding and seeding as had already been placed, resort was had to the use of poles for bank protection. This method of protection was not employed with the idea of preventing sand from sliding into the ditches but to prevent the wind from blowing the sand out of the cuts.

Poles up to 6 in. in diameter were used. They were spaced about 3 ft. apart and laid in such a manner as to rest upon the back slopes of the cuts at right angles to the center line of the road. As many dead poles as could be secured were used in order that the cutting of green trees might be avoided.

Though this method of protection has not been extensively used, it has been found quite effective and plans are being made by the State Highway Department to use it on other sections of new construction. Work on this particular section was carried out a number of years ago.

The information contained in this article was supplied by W. J. Kingscott, supervising engineer of the Michigan State Highway Department.

From Job and Office

Hints that Cut Cost and Time

POLES PROTECT SAND CUTS FROM STORM WINDS

Adjusting Co-Ordinate Stations Derived from Different Centers and Azimuths

BY L. F. HAMMOND
Concord, N. H.

SOME time ago I had to combine a land survey of several thousand acres to a mine survey where different centers of co-ordinates were used and the azimuth varied by over a degree. I found no formula at hand to suit this condition so spent some time computing the tables printed herewith for all conditions. It is a task to recompute an entire traverse, with errors possible in changing the azimuth of each course (providing original notes are obtainable and clear), when only a few stations or ties are desirable.

No tables are required except those from which the sine and cosine of the difference in azimuth can be computed. The method is simple, with small chance of error, is easily checked, is rapid and can be readily followed out on a calculating machine. Particular attention, however, must be paid to plus and minus signs; if the result is a minus quantity the direction is opposite to the old one.

If there is no difference in azimuth between the surveys it becomes a Case III condition; if no difference in centers but in azimuths only, it is a Column 5 condition, Case I or II.

EXAMPLE: Assume the accepted azimuth (z) is West of the other by 1 deg., and the co-ordinate of the center is North 1,800 ft. and West 15 ft., t and g distances respectively. This is a Case II, Column 2, condition. Say a station to be calculated is, according to previous survey, North 1,240 ft. and East 480 ft.;
Then,

$y = t \cos z - g \sin z - n = 1{,}240 \times 0.9998 - 480 \times 0.0175 - 1{,}800 = -568.65$; as this result is a minus quantity it indicates that the co-ordinate is opposite to the original, or South.

$X = g \cos z + t \sin z + m = 480 \times 0.9998 + 1{,}240 \times 0.0175 + 15 = +516.60$; being a plus quantity, the direction is East.

Definitions:

Z = difference in azimuth, East or West.
g = original longitude of station.
X = new longitude.
t = original latitude of station.

From Job and Office

For Contractor and Engineer

Tables for Computation of Survey Combining Surveys with Different Azimuths and Different Centers

CASE I—WHEN THE NEW AZIMUTH IS EAST OF THE OLD

Direction of NEW center from Old

Old Quadrant in which station is located	NE (1)	NW (2)	SW (3)	SE (4)	Same (5)	Old Quadrant in which station is located
NE	x	$g\cos Z-t\sin Z-m$	$g\cos Z-t\sin Z+m$	$g\cos Z-t\sin Z-m$	$g\cos Z-t\sin Z$	x
	y	$t\cos Z+g\sin Z-n$	$t\cos Z+g\sin Z+n$	$t\cos Z+g\sin Z+n$	$t\cos Z+g\sin Z$	y
NW	x	$g\cos Z+t\sin Z+m$	$g\cos Z+t\sin Z-m$	$g\cos Z+t\sin Z+m$	$g\cos Z+t\sin Z$	x
	y	$t\cos Z-g\sin Z-n$	$t\cos Z-g\sin Z+n$	$t\cos Z-g\sin Z+n$	$t\cos Z-g\sin Z$	y
SW	x	$g\cos Z-t\sin Z+m$	$g\cos Z-t\sin Z-m$	$g\cos Z-t\sin Z+m$	$g\cos Z-t\sin Z$	x
	y	$t\cos Z+g\sin Z+n$	$t\cos Z+g\sin Z-n$	$t\cos Z+g\sin Z+n$	$t\cos Z+g\sin Z$	y
SE	x	$g\cos Z+t\sin Z-m$	$g\cos Z+t\sin Z+m$	$g\cos Z+t\sin Z-m$	$g\cos Z+t\sin Z$	x
	y	$t\cos Z-g\sin Z+n$	$t\cos Z-g\sin Z-n$	$t\cos Z-g\sin Z+n$	$t\cos Z-g\sin Z$	y

CASE II—WHEN THE NEW AZIMUTH IS WEST OF THE OLD

Direction of NEW center from Old

Old Quadrant in which station is located	NE (1)	NW (2)	SW (3)	SE (4)	Same (5)	Old Quadrant in which station is located
NE	x	$g\cos Z+t\sin Z+m$	$g\cos Z+t\sin Z+m$	$g\cos Z+t\sin Z-m$	$g\cos Z+t\sin Z$	x
	y	$t\cos Z-g\sin Z-n$	$t\cos Z-g\sin Z+n$	$t\cos Z-g\sin Z+n$	$t\cos Z-g\sin Z$	y
NW	x	$g\cos Z-t\sin Z+m$	$g\cos Z-t\sin Z-m$	$g\cos Z-t\sin Z+m$	$g\cos Z-t\sin Z$	x
	y	$t\cos Z+g\sin Z-n$	$t\cos Z+g\sin Z+n$	$t\cos Z+g\sin Z+n$	$t\cos Z+g\sin Z$	y
SW	x	$g\cos Z+t\sin Z+m$	$g\cos Z+t\sin Z-m$	$g\cos Z+t\sin Z+m$	$g\cos Z+t\sin Z$	x
	y	$t\cos Z-g\sin Z+n$	$t\cos Z-g\sin Z-n$	$t\cos Z-g\sin Z+n$	$t\cos Z-g\sin Z$	y
SE	x	$g\cos Z-t\sin Z-m$	$g\cos Z-t\sin Z+m$	$g\cos Z-t\sin Z-m$	$g\cos Z-t\sin Z$	x
	y	$t\cos Z+g\sin Z+n$	$t\cos Z+g\sin Z-n$	$t\cos Z+g\sin Z+n$	$t\cos Z+g\sin Z$	y

CASE III—WHEN THE NEW AZIMUTH IS UNCHANGED

Direction of NEW center from Old

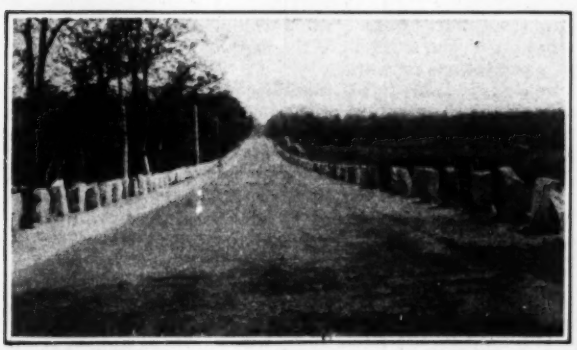
Old Quadrant in which station is located	NE (1)	NW (2)	SW (3)	SE (4)	Same (5)	Old Quadrant in which station is located
NE	x	$g-m$	$g+m$	$g-m$		x
	y	$t-n$	$t-n$	$t+n$		y
NW	x	$g+m$	$g-m$	$g+m$		x
	y	$t-n$	$t-n$	$t+n$		y
SW	x	$g+m$	$g-m$	$g+m$		x
	y	$t+n$	$t-n$	$t-n$		y
SE	x	$g-m$	$g+m$	$g-m$		x
	y	$t+n$	$t-n$	$t-n$		y

y = new latitude.
m = longitudinal distance from new center to old center of co-ordinates.
n = latitudinal distance from new center to old.

Stone Guard Rail Proves Cheapest for Massachusetts Highway

DURING the year 1924 stone guard rail placed by the Massachusetts Department of Public Works, Division of Highways, amounted to 75c. per lineal foot and wooden guard rail 79c. The amount of guardrail stone placed approximated 1 mile in length. The specifications covering construction methods where guard stone is employed are as follows:

Guard stones must be placed at the edges of embankments and at such places along the road as the engineer may deem necessary. The stones must consist of boulders or ledge stone, sound and durable, not less than 3½ ft. nor more than 5 ft. in the longest dimension and less than 12 in. in thickness or 2 ft. in width. The stones are set 12 in. into the ground and that portion nearest the roadway must be not less than 3 ft. from the hardened surface. The stones shall be not more than 4 ft. apart at their nearest point. All stones are so placed that their height above the ground is as nearly uniform as possible and not less than 2½ ft., with their greatest thickness parallel to the center line.

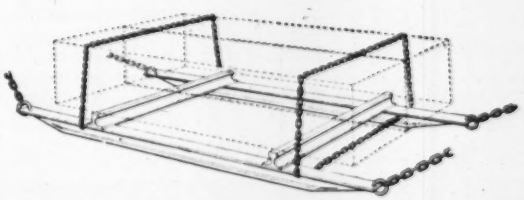


GRANITE GUARD RAIL ON MASSACHUSETTS HIGHWAY

The guard stones are paid for at the contract unit price per lineal foot measured in place, such measurement including the space between the stones. The price also includes stone in place and all excavation except ledge rock and the removal of excavated material.

Job and Office Notes

A Heavy-Duty Sled for general use by contractors has been recently devised, says the September issue of "Oxy-Acetylene Tips," published by the Linde Air Products Corporation. The ends of two lightweight rail sections



are mitered with the cutting blowpipe, ball of the rail down. Two rail sections are oxwelded to the flange of the rails, which form the runners, about one-third of the distance from each end. To the ends of the runners are welded heavy rings for coupling up to the motive power. Such holes are pierced with the cutting blowpipe through the web of the rails near the ends. This skid, while relatively simple in construction, provides a solution to erstwhile transportation problems encountered in a new subway which the contractor who devised it is building, and should also be of assistance in many mills and plants. This is another example of the utility of the oxyacetylene process.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Was Gem Lake Dam Disintegration Due to Underburned Cement?

Sir—The first time it was apparent to the writer that there was something wrong with the Gem Lake dam, the deterioration and subsequent repair of which are under current discussion in your pages, was about three years after completion of the structure. A very heavy white deposit consisting of practically pure calcium carbonate was noticed on the downstream face of the dam, especially in a zone 30 ft. wide, the top of which was located approximately 30 ft. below the crest of the dam. The thickness of the deposit had gradually increased to ½ in. in places and it seemed to keep on increasing.

It is perhaps impossible entirely to avoid this white deposit on the downstream face of a dam at least in moist spots, but in this case the deposit was too heavy to be harmless and the fact that it kept increasing was alarming.

The small white deposits often seen on the downstream face of dams originating merely from the leaching of the free lime in the cement or from the leaching of whatever laitance there may be accumulated in the construction joints, are harmless, but when these materials are all leached out the process of leaching should stop and nothing further should happen. In the case of the Gem Lake dam the process never stopped; the cement itself broke down into lime and clay in the zone subject to water pressure during the coldest weather.

The cement passed the usual test. It might, however, have been somewhat underburned without being noticed, causing it to be on the point of unstability when exposed to the severe cold, which it was called upon to withstand.

Under ordinary conditions, the concrete undoubtedly would have kept its strength, but under the severe climatic conditions imposed upon it in the middle zone, the concrete deteriorated and lost its strength.

The deterioration undoubtedly started at the construction joints, since they are naturally the weakest points in the structure, but if the leaching had only been confined to whatever laitance or free lime there might have been in the joints, the process would soon have stopped. In the zone subject to heavy frost, during such time that the water level fluctuated, the concrete was practically equally weakened all over while still in good condition above and below.

If the sand had been the cause of the poor showing of the concrete, it could be expected that there would have been good and bad spots of concrete, since three kinds of sand were used, sometimes washed and sometimes unwashed

The sand used was found along the shore of the natural Gem Lake after it was lowered due to dam excavation. Approximately half of this sand required washing in order to eliminate excesses of clay and vegetable matter. Mortar briquets were made and tested in order to determine when it was necessary to wash the sand.

The rock used in the cement has, among other things, been tested for its solubility in water and it has been found that the calcium carbonate deposit on the downstream surface of the dam does not originate from the rock.

The water was found to be very clear. The water contents of the concrete were kept to a minimum for reinforced watertight concrete. The crushing strength of the concrete, somewhat over 2,000 lb. per sq.in., was not quite so high as ordinarily would be expected for the richness of mix used. There are two reasons for this. The shape of the crushed rock was somewhat elongated and the concrete in the reinforced arches cannot be deposited as dry as required for maximum strength, when it has to be watertight at the same time. The stresses used in the design were conservative and the structure was therefore never overstressed due to the water load.

Inasmuch as the deposit of calcium carbonate continued to accumulate in the downstream face and inasmuch as it cannot be traced to the water, rock or sand, the writer has come to the conclusion that the cement itself broke down gradually during the cold weather, when it was called upon to develop its greatest resistance, the lime portion of the cement being leached out continually and deposited as calcium carbide. The porosity of the arches was thereby gradually increased and the frost action on the water in the pores accelerated the destruction of the arches by crushing action.

The Agnew Lake dam, built practically of the same material as the Gem Lake dam on the same stream 500 ft. lower in elevation, is still in first-class condition The water level in this reservoir is not lowered appreciably during the cold season and snowdrifts protect the downstream face to a great extent from the extreme cold weather.

Since there is not a great deal of difference in cost between a multiple-arch dam having spans of 40 ft. and one having spans of 50 ft., the writer has favorably considered arches of 50-ft. span on recent designs of multiple-arch dams.

A greater thickness of the arch is required, but this should make it possible to keep the construction joints tight just by careful workmanship, without plastering the upstream side. It can hardly be expected that a plaster face will have a long life, when an arch is so thin that heavy frost can penetrate the concrete, as the adhesion of the plaster cannot be expected to be 100 per cent over the whole area.

LARS JORGENSEN,
Constant Angle Arch Dam Co.

San Francisco, Calif.,
Sept. 22, 1925.

Ward Latitude and Meridian Determination Now Found Inapplicable

Sir—In your issue of July 2, p. 25, you published an article describing a method of determining meridian and latitude by Howard R. Ward.

This method appears to have several advantages over the usual Polaris observation at any hour angle, particularly as the true time is not required, nor an understanding of how to use sidereal time. It appears to me that the practical possibilities of the method would justify an explanation of how the various "time intervals" and factors are derived so that these quantities could be computed for years later than 1926 without an extended exploration into the field of spherical trigonometry.

Undoubtedly the method can be made all that is claimed for it, "simple, rapid, and accurate," but I venture to suggest that there is some omission or mistake in the article referred to, as I have tried the method out several times, both for azimuth and latitude with disappointing results.

Using the same observed altitudes of Polaris and the same "times" and reducing by the method of Polaris at any hour angle gives a result which differs by four minutes from Ward's method. A reliable map verifies the old method of reduction.

D. J. FEE,
Assistant Engineer, Mt. Shasta Power Corporation.

Sonora, Calif.,
Aug. 17, 1925.

Sir—Mr. Fee states that he secured disappointing results with the "Ward Method of Meridian and Latitude Determination." The error is in the method and probably not in his observations or work.

On Jan. 5, 1925, the U. S. Coast and Geodetic Survey advised me that "we have studied your method and consider it well worth publishing. We have checked a few values in your factor table and find them correct." But on July 10 they wrote:

"Regret to inform you that we shall have to reverse our first opinion. Your method is wrong in principle. It will not work for hour angles other than 6 or 18 hours for azimuth and 0 and 12 hours for latitude. . ."

I too regret that it should have been published before the limitations were found. Tests that checked happened to be made on hour angles that did not show divergence from rigid formulas.

HOWARD R. WARD.

Wharton, N. J.,
Sept. 7, 1925.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Chicago Diversion Again Before Supreme Court

Minnesota, Ohio and Pennsylvania Join Wisconsin in Complaint Against Lake Diversion.

Diversion of water from Lake Michigan by the Chicago Sanitary District entered a new phase of court procedure Oct. 5, when, on the opening day of the term of the United States Supreme Court, a motion was entered by Attorney General H. L. Ekern of Wisconsin for permission to file an amended bill in the suit of that state against the state of Illinois and the Chicago Sanitary District in which amended bill the states of Minnesota, Ohio and Pennsylvania join Wisconsin as complainants. The Court took the motion under advisement.

Attorneys representing Illinois and the sanitary district, who were present, immediately filed notice of opposition to the motion for an amended bill.

The amended bill would replace the complaint filed by Wisconsin in 1922, on which no action has been taken before the Supreme Court because of priority for the suit of the federal government against the sanitary district to restrain excessive diversion, which was decided in favor of the government by the Court last spring.

The new bill, in which the four states would join, seeks to prevent any withdrawal of water from Lake Michigan by the Chicago Sanitary District, on the ground that withdrawals at Chicago already have lowered the lake levels six inches and that navigation on the Great Lakes as a whole is being interfered with seriously with resultant great loss to commerce and navigation. The bill also questions the authority of the Secretary of War to grant a permit to the sanitary district for any permanent diversion whatsoever.

Involved in the amended bill, indirectly, is the Great Lakes-St. Lawrence River deep waterway project. According to Attorney General Ekern of Wisconsin, public sentiment in Canada is urging that the lake level question be determined before definite steps are taken toward developing the St. Lawrence route.

The amended bill alleges that the diversion of water at Chicago "is interfering with the right of the people of Wisconsin, Minnesota, Ohio and Pennsylvania to the free and unobstructed navigation of Lakes Michigan, Huron, Erie and Ontario, and the navigable waters between the said lakes and from said lakes into the Mississippi river and the Atlantic ocean, which rights belong to the said people of Wisconsin, Minnesota, Ohio and Pennsylvania both by the common law and by the express guaranty contained in the ordinance for the government of the territory of the United States northwest of the River Ohio, enacted by Congress June 13, 1787."

It is understood that the State of Michigan intends later to file a separate suit against Illinois and the Chicago Sanitary District, taking the position that not even Congress has the power to authorize diversion of water from the Great Lakes.

Engineering Fifty Years Ago

From *Engineering News*, October, 1875

THE WORK at the mouth of the Mississippi was commenced by Capt. Eads on the 14th of June and of the preliminary lines of piles, 9,860 feet have now been driven on the east jetty, and 1,950 on the west jetty, while 3,500 feet of the mattress foundation have been securely laid. The laying of these mattress foundations goes on at the rate of 300 linear feet per day. These mattresses, 40 feet wide and two feet thick, are towed into position and fastened to the piles, and in a few hours the deposit of sediment from the current so fills the interstices as to sink them.

Form Cascade Tunnel Association in Seattle

Organization of the Cascade Tunnel Association was effected in Seattle on Sept. 19 at a meeting which adopted a constitution and by-laws, elected officers, appointed committees and adopted resolutions. The officers are: President, Austin E. Griffiths, judge of the Washington Superior Court, City-County Building, Seattle; vice-president, C. L. Babcock, Tacoma; secretary, Edgar C. Snyder; assistant secretary and treasurer, Harold Stewart.

The purpose of the association is to encourage and promote the idea proposed several years ago by Gen. H. M. Chittenden of a tunnel through the Cascade Mountains to be built with state and national funds. The principal resolution adopted at the organization meeting requests the next session of the Washington Legislature to appoint a commission of experts "to ascertain and report the most feasible and advantageous route" for a publicly-owned tunnel under the Cascade Mountains for automobile and railroad use. Annual meetings of the association are to be held beginning next January.

The great advantage of such a tunnel to trade, the fact that there is no highway across the mountains open in the winter, and other arguments on the need of such a tunnel are set forth in a leaflet entitled, "The Cascade Tunnel," issued by the association.

To Force Co-operation in Bridge Deadlock

No Solution of Philadelphia-Camden Bridge Muddle Found—Forced Co-operation Planned

No solution of the deadlock over toll-collection on the Philadelphia-Camden bridge was reached at the joint meeting of the New Jersey and Pennsylvania state commissions on Oct. 2. The hoped-for results of conferences between the state attorneys to find a means of adjusting the difference between the states did not materialize. Instead, the two commissions cast opposing votes on new contracts which were to be authorized, which action prevents progress toward awarding these contracts and continues the deadlock established at the Sept. 18 meeting. The Pennsylvania Commission thereafter, in separate session, decided to force completion of the bridge by court action compelling New Jersey to co-operate without adjustment of the dispute over tolls.

Contracts for wrapping the cables with serving wire, for ornamental metalwork, for electrical equipment, and for completion of the Camden approach, all of which are necessary to open the bridge to traffic, were presented to the commission for approval and authority to advertise for bids. Before this matter was voted upon, an opinion of Attorney-General Katzenbach of New Jersey was read, stating that New Jersey is bound by the laws providing for the construction of the bridge to collect tolls, and that the New Jersey commission could not authorize further construction contracts so long as Pennsylvania refuses to authorize toll charges for the use of the bridge. Roll-call on resolutions to approve the contracts and advertise for bids showed the Pennsylvania members all voting yes and the New Jersey members all voting no except two members from southern New Jersey, of whom one voted yes and one declined to vote. A majority vote of each commission is required for approval of resolutions.

Court Decision Asked

Immediately following adjournment of the joint meeting the Pennsylvania commission met and unanimously approved a resolution calling upon the Attorney-General to secure a court decision to determine if New Jersey can legally refuse to award the contracts necessary for completion of the structure. The city of Philadelphia, partner in the enterprise, will take no part in the suit, in order that it may be taken at once to the U. S. Supreme Court. The action will be based upon an implied contractual obligation of New Jersey to Pennsylvania for construction of the bridge, created by the

(*Continued on p. 608*)

Mokelumne Water Supply Contracts Let

Gravity System Chosen Uses 85 Miles of Electrically Welded Pipe—Awards Total $11,751,427

Although a supply line involving pumping was favored by the East Bay Municipal Utility District in and around Oakland, California, as a result of earlier studies of the Mokelumne water supply project, the final decision after alternative bids had been received was in favor of a gravity supply line. Announcement has just been made of contract awards totaling $11,751,427 which have been made by the district on bids opened Sept. 4. Included in the awards is 85 miles of electrically welded pipe to be manufactured in Oakland, Calif.

All of the awards were to lowest bidders and were in accordance with recommendations of the district's board of consulting engineers, consisting of C. E. Grunsky, William Mulholland, G. W. Goethals and A. P. Davis. The bids were, according to this board, "satisfactory in number and character and gratifying as to prices." A description of the Mokelumne project appeared in *Engineering News-Record*, Dec. 12, 1924, p. 960.

Low bidders on dam and intake tunnel, on which no awards have yet been made were: On the intake tunnel, Charles and George K. Thompson, $624,054; and on Lancha Plana dam, Lynn S. Atkinson, Jr., $3,081,378.

The gravity delivery is to cost about $1,208,000 more than the pumping scheme, and according to the district board of engineers, "this cost is partly offset by the capitalized pumping costs during the period of several years within which the gravity delivery will be sufficient. After that, both plans will require pumping. The saving in capitalized pumping cost is less than the difference in price, but the increased life of the steel pipe, due to the heavier weights involved in the gravity system will, we believe, more than offset the larger price of the gravity system."

In the matter of selecting electrically welded pipe in which the diameters will vary from 60 to 65 in. and heads will range up to 380 ft., the board of engineers states: "The welding of pipe by electric methods is a comparatively new art, particularly for such heavy pipe as required by this aqueduct and your board has given careful and special consideration to the dependability of this product. Samples of the work have been submitted that show beyond question the possibility of securing a welded joint by this method having 100 per cent efficiency, and the tests required are ample to secure the required efficiency on every joint. Aside from these tests, the work is guaranteed by the association of large manufacturers of the highest standing and long experience, and by a heavy bond to guarantee its proper execution. We, therefore, have no hesitation in recommending the acceptance of this method of manufacture, which will save the District more than $4,000,000 over prices that could be obtained for any other method."

The specifications call for the completion of the aqueduct to the Lancha Plana dam in 30 months after signing the contract, and it is believed that the dam and the intake tunnel can likewise be completed by that time.

CONTRACTS AWARDED ON MOKELUMNE PROJECT

Items	Bidders	Amount of Bid
Lafayette Tunnel	Smith Brothers, Inc.	$1,101,822.00
Walnut Creek Tunnel	T. E. Connolly	152,906.00
Walnut Creek Pump House	Twohy Brothers Co.	23,469.00
Walnut Creek Pumping Machinery	Pelton Co.	28,245.00
Pipe Lines:		
Lafayette Tunnel to Peat Lands	Twohy Brothers Co.	3,653,107.00
Across Peat Lands	Twohy Brothers Co.	3,112,820.00
Peat Lands to Grant School	Twohy Borthers Co.	2,007,361.00
Grant School to Intake Tunnel	Twohy Brothers Co.	1,671,697.00
Total		$11,751,427.00

WASHINGTON NOTES

PUBLIC pressure for the elimination of grade crossings is being reflected in the larger sums being made available for that purpose by the states and by the increasing insistence of the Bureau of Public Roads for the separation of railroad and highway before approving federal aid projects. The practice in many instances of withholding approval for a considerable sector of road on either side of grade crossings over important rail lines is calculated to hurry the ultimate elimination of the crossing, it is believed. This action is taken, however, not with the idea of forcing the construction of an underpass or an overpass, but to allow of the relocation of the road. In many instances it is found that other sites are preferable for such construction than the crossing which has been in use.

WITH the resignation of F. B. Tough as director of the leasing division of the U. S. Geological Survey (noted in our personals column), the government will abolish the position and establish three field divisions under the jurisdiction of district supervisors who are engineers in charge with full authority and responsibility to conduct operations and represent the government. The divisions include the Rocky Mountain District with headquarters at Casper, Wyo., the Pacific district with headquarters at Taft, Calif., and the Mid-continent district with headquarters at Muskogee, Okla. Centralization of authority in the engineers in charge of these districts has resulted from the constant development of operating problems necessitating immediate decisions and requiring a high degree of skill in oil-field operations. Previously, all questions of administration were referred to the Washington headquarters of the Geological Survey.

INDICATIONS are that Montana is willing to co-operate with the settlement provisions of the appropriation for the Sun River project. It has been suggested that the governor of Montana submit to the Secretary of the Interior an exact outline of what the state is prepared do in the way of extending credit to settlers and underwriting funds obtained for this purpose from other sources. It also is suggested that he state the interest which it is proposed to charge and the length of time for which the loans will be made.

The people of Great Falls who are proposing to back a corporation to finance settlers are known to appreciate the fact that irrigation projects from this time forward must be in the hands of skilled workers and must be developed intensively with crops of high acreage value, with full advantage taken of all opportunities to produce livestock. It is recognized that by these means only can high operation and construction costs be met.

NO FEDERAL funds are likely to be voted at the coming session of Congress for any project on the Colorado River, Commerce Secretary Hoover predicts. The East, at best, he says, is not anxious to see money poured into western ventures. If there is disagreement in the West a valid excuse at once is afforded other sections to defer action or vote down the proposition. Secretary Hoover obviously was referring to the Swing-Johnson bill, which provides for the construction of the Boulder dam and the All-American canal to supply Colorado River water to the Imperial Valley in California.

Diamond Creek Hearing on Oct. 20

Final hearing on the Girand application for a license for power development on the Colorado River at Diamond Creek, Ariz., has been set by the Federal Power Commission for Oct. 20. The hearing had been scheduled for the current month, but has been postponed on request of the applicants and of Colorado interests in opposition. The hearing will be held in the office of the Secretary of War at 2:30 p.m.

To Force Co-operation in Bridge Deadlock

(*Continued from p.* 607)

laws of the two states when the work was started, and upon the wording of the New Jersey law stating that "upon completion" of the bridge the commission has power to negotiate with Pennsylvania for maintenance, operation and tolls. The existing Pennsylvania commission will not control the bridge after it is completed and therefore would have no power to make agreements on tolls even though the Pennsylvania legislature had not provided specifically that tolls should not be collected.

Goldbeck Leaves Government to Direct Crushed Stone Studies

A. T. Goldbeck, chief, Division of Tests, United States Bureau of Public Roads, has resigned to become director of the newly organized Bureau of Engineering of the National Crushed Stone Association, the purposes of which are as noted on p. 612 of this issue. His office will continue to be in Washington.

Mr. Goldbeck has had a long and valuable experience in the testing and study of materials. He graduated from the University of Pennsylvania in 1906 as a civil engineer. For some years thereafter he taught at Pennsylvania and at Lafayette. In 1910 he became attached to the Office of Public Roads as engineer of tests. From 1913 to 1915 he was assistant engineer in charge of the municipal laboratory of the city of Philadelphia, but at the latter date he returned to Washington as engineer of tests of the Bureau of Public Roads, initiating and continuing the elaborate studies into the nature of road materials which that bureau has been conducting since that date. He is chairman of Committee C-9 Concrete and Concrete Aggregates of the American Society for Testing Materials; the sub-committee on Nonbituminous Road Materials of Committee D-4 of the same society; of the Committee on Road Materials of the Federal Specifications Board and of the Committee on Structural Design of Highways, of the Highway Research Board of the National Research Council. He is also member of a number of other technical committees and societies.

Mr. Goldbeck will have associated with him as secretary of the National Crushed Stone Association J. R. Boyd, who has been an assistant engineer of testing in the United States Bureau of Public Roads.

Live, Practical Topics on Program California Section A.W.W.A.

In framing the program for the sixth annual convention of the California Section, American Water Works Section, to be held in Santa Cruz, Calif., Oct. 15 to 17, "we have tried," says the secretary, "to come 'down to earth' for the water-works superintendent and discuss his every-day problems." Indicative of this are the following topics, with the names of the men who are to lend the discussion: Service Installation Methods and Standards, by George Read, superintendent, Meter and Service Department, Bureau of Water-Works and Supply, Los Angeles; Meter Maintenance Methods, by J. H. Fagg, Pacific Gas & Electric Corp., Stockton; Jointing Methods for Water Mains, by Clark H. Shaw, chief engineer and superintendent, Long Beach Water Department; Use of Mechanical Equipment in Trenching, Backfilling and Pipe Laying, by Thomas Brooks, assistant superintendent, Bureau of Water Works and Supply, Los Angeles.

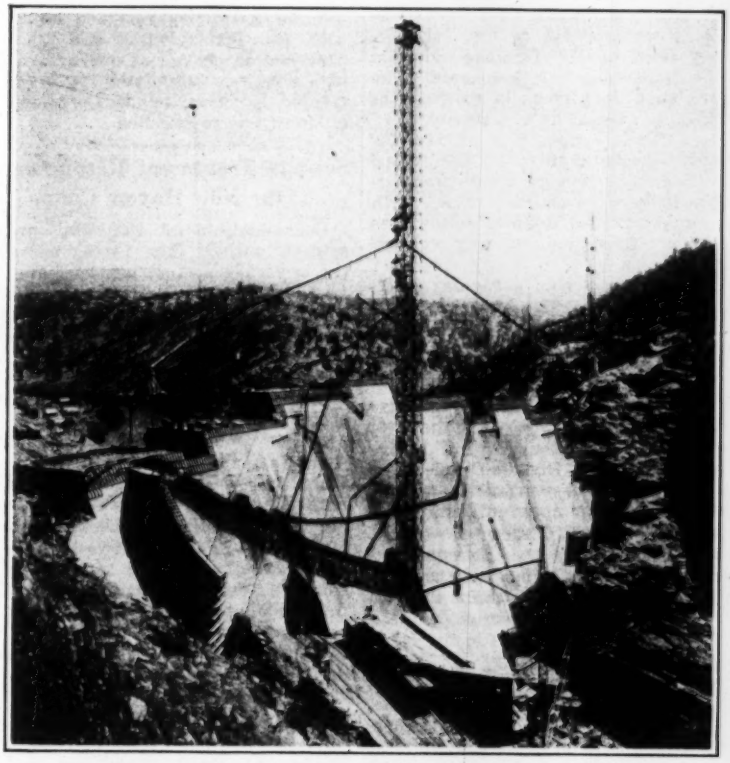
Among the other topics on the program are: Design and Construction of Concrete-Lined Distribution Reservoirs, by I. E. Flaa, chief draftsman, Spring Valley Water Co., San Francisco; Design of Balancing Reservoirs and Standpipes for Flat Cities and Communities, by E. K. Barnum, engineer, Fresno City Water Co.; Methods Used in Moving 36-in. Riveted Steel Water Main, by Judy I. Prugh, superintendent, Distribution, Sacramento Water Department; Relation of Water Pressures, Service Sizes and Interior Fixtures to Complaints of Inadequate Water Service, by V. E. Perry, assistant manager water sales, Spring Valley Water Co., San Francisco; Methods of Protecting Services and Meters During Street Grading and Paving Operations, by P. Diederich, superintendent, Public Service, Glendale.

The chairman of the section is George W. Pracy, superintendent Spring Valley Water Co., San Francisco, and the secretary is S. B. Morris, superintendent and chief engineer, Pasadena Water Department.

Cleveland, Ohio, Invites Bids for Southerly Sewage-Works

Bids for the southerly sewage-works, Cleveland, Ohio, are to be received until Oct. 28 by A. A. Hoare, commissioner of purchases and supplies. The works include intercepting sewer, grit chambers, two-story settling tanks, pumping station, dosing tanks, trickling filters, humus tanks, sludge-drying beds, pipe lines, conduits, buildings and appurtenances. The main quantities are: Excavation, 200,000 cu.yd.; concrete, 42,000 cu.yd.; reinforcement, 2,000 tons; cast-iron pipe, 900 tons; buildings, 300,000 cu.ft.; stone for trickling filters, 97,000 cu.yd.; 8½-ft. intercepting sewer, 3,600 ft. Plans and specifications for the work have been made by George B. Gascoigne, consulting engineer, Cleveland. Robert Hoffmann is commissioner of engineering and city engineer of Cleveland.

Year's Progress in Construction on Exchequer Dam



EXCHEQUER DAM, CALIF., ONE YEAR AFTER STARTING
Partially completed wingwall of spillway appears in left foreground. Powerhouse foundations seen in stream bed.

One year after the signing of the contract for the construction of Exchequer dam for the Merced Irrigation District in California, the work had been advanced to the stage shown in the accompanying illustration. This view, taken on Aug. 18, shows the structure with 225,000 cu.yd. of concrete in place. (The yardage in the completed dam will be 400,000). As shown in this picture the steel tower for handling concrete has been raised to its final height of 475 ft. which the contractors, Bent Bros. of Los Angeles, suggest is a record height for a structure of this sort.

At the stage of the work shown, flow of water through the dam had been stopped by temporary planking in the opening left at stream bed level. Final closure is not to be made, however, until the 17-mile railroad relocation around the reservoir has been completed so that the Yosemite Valley R.R., here shown passing through the dam, can use the new route.

The dam, which was described in *Engineering News-Record*, May 28, p. 880, is an arched structure curved on a radius of 675 ft. It will have a total height of 330 ft. and a crest length of 955 ft.

Conference Finds Jurisdictional Awards Board Needed

Representatives of all interests concerned with the functions of the Board of Jurisdictional Awards joined in voicing the sentiment that the construction industry needs an organization of this character for the settlement of disputes between trades, and that its activities should be continued, at a conference held in Washington, Sept. 21 and 22.

The conference had been called by the board, following its meeting at Atlantic City in July, to sound sentiment regarding the usefulness of the board, the effects of its decisions, its general policy, etc.

Twelve trades unions were represented at the conference by their international presidents or vice-presidents, and organizations of engineers, architects, contractors, sub-contractors and others also were represented. Secretary of Labor J. J. Davis told the conference the existence of a board of this character is essential. Similar sentiments were expressd by Dr. John M. Gries, chief of the Housing Division of the Department of Commerce. The others were unanimous in viewing the work of the board as a necessity.

One of the suggestions offered for possible strengthening of the board was its employment of a full-time secretary to keep in constant touch with the situation. No definite action was taken, or attempted, on any suggestion.

The board will hold a regular meeting to consider disputes at Washington, Nov. 9.

Swing Bridge Damaged by Steamer Collision

A freight steamer ran into the west approach span of the Ash St. bridge over the Maumee River at Toledo on Sept. 21 and wrecked part of the sidewalk framing, but apparently did little damage to the main structure of the span. The steamer was bound downstream, and at the same time another steamer was coming upstream through the same opening of the draw, while a third vessel was making for the other opening. The interchange of signals between the two approaching steamers did not clear up the situation in time, and the steamer bound down, attempting to come to a stop, struck the rest pier of the draw and then glanced off in the direction of the approach span, striking it near the safety gate at the end of the draw. The approach was crowded with automobiles waiting to pass, but no injury resulted beyond the destruction of the sidewalk framing at the point of impact.

Michigan Engineers to Meet

The Detroit Engineering Society, Michigan Engineering Society, and Grand Rapids Engineering Society have agreed to sponsor "A Conference of the Engineering Profession of Michigan" to be held at the Hotel Tuller, Detroit, Mich., Feb. 4, 5 and 6, 1926. Details of the papers and speakers have not been arranged as yet.

Atterbury Succeeds Rea as President of the Pennsylvania

William W. Atterbury, vice-president of the Pennsylvania R.R. system, was elected president on Oct. 1 to succeed Samuel Rea whose retirement was announced in our issue of last week. Mr. Atterbury began his services with the Pennsylvania R.R. in 1886 when he entered the Altoona shops as an apprentice following his graduation from college. Subsequently he advanced through the mechanical department until, in 1901, he became general superintendent of motive power. In 1903 he was appointed general manager of lines east of Pittsburgh and in 1909 was elected fifth vice-president in charge of operations and in 1912 was elected vice-president in charge of operations. In 1917, Mr. Atterbury went to France with the American Expeditionary Forces and was appointed director general of transportation with the rank of brigadier general, which position he held until after the end of the war. In 1920, General Atterbury resumed his duties with the Pennsylvania R.R. as vice-president in charge of operations, and, in 1924, was appointed to a newly created position of vice-president in order to relieve Mr. Rea.

Sewage Treatment Recommended for New Haven, Conn.

Consolidation of the five present sewage outlets into three, extending the sewerage system into outlying districts and into portions of adjacent towns, and the construction of sewage-works have been recommended to the Board of Aldermen of the City of New Haven, Conn., by Edward S. Nettleton, city engineer. Grit chambers, fine screens and sedimentation tanks are proposed, to be followed by chlorination if the latter is proved to be necessary. Mr. Nettleton's report recommends the immediate construction of a 40-m.g.d. plant at East St. at an estimated cost of $600,000. The other two plants, with capacities of 28 m.g.d. and 14 m.g.d. would be erected when appropriations for the purpose were made. There is recommended for construction as rapidly as funds become available 8 miles of storm-water sewers to cut off 488 catchbasins from the present combined and overburdened East St. system. As to untreated manufacturing wastes, Mr. Nettleton advises that the direct discharge of these into the harbor or rivers be forbidden; that manufactories located below sewer levels be required either to treat their sewage or to install pumps and discharge it into the city sewers and that all establishments whose operations cause the sewage to be discolored shall take proper measures to neutralize the color before any of their wastes are discharged into the city system. At some future time, Mr. Nettleton says, it may be advisable to convey the effluent from the proposed sewage-works through a submerged outfall to the deeper channels of the harbor. The plans as outlined are believed to be sufficient for the growth of the city for the next 40 years.

Random Lines

How Many Believe This One?

Engineer Files Petition in Bankruptcy; Income Tax Largest of Debts

A construction engineer of Darien, Conn., filed a petition in bankruptcy today, listing liabilities of $294,986.19 and assets of $175,406.44. The United States Government is the largest creditor, the petition showing an income tax payment due amounting to $99,612.30.—Associated Press Dispatch.

* * *

O Tempora! O Mores!

"New Concord's water supply has been exhausted by the return of 500 students to Huskingum College. Following the depletion of the supply, which was reported to the state health department Monday night, T. R. Lathrope, assistant sanitary engineer of the department, was sent to the village to devise relief measures."

* * *

Some Belated Entries

Sir—One more for your Evolution Museum of Engineering:

Seward C. Simons, Los Angeles Chamber of Commerce *engineer of market development*, was the speaker before the Lions' Club today.

Within sight of my home there is an extension to a religious institution now being built under the direction of a gentleman who describes himself on a large signboard as a *"Visualizing Architect."* I think this is the best yet; now for the *"Crystallizing Engineer."*—D. D.

* * *

The Lure

Extract from a letter from an engineer in Chile:

"I tried working in New York after I left Chile in 1922, drifted from there to California liked it very well there but wages were too small to suit me, moved into Mexico was fixed pretty good but the revolution put a finish to the job; from there I moved back to South America, this time to Bolivia, going along nicely when a French company took over the property and at once a new general manager was sent over from France and all Americans were given their walking papers; from here I landed back in New York, made up my mind that I would never leave the Good Old U. S. A. again but no matter how hard I tried to stay my feet got so itchy that I packed up and here I am again back again. I guess I might be branded with the T. T. T.: Typical Tropical Tramp. There is something that brings one back and I don't know what it can be as there are several others in the same boat."

Or as Kipling's "Tramp Royal" has it:

"For to admire and for to see
For to view this world so wide
It never did no good to me
But I couldn't stop it if I tried."

Many New Bridges Proposed for Chicago

Following the recommendation of the Chicago City Plan Commission to bridge the Chicago River by an extension of the outer drive in Grant Park directly north to an intersection with Lake Shore Drive the bridge department of the Department of Public Works has recommended the construction of twenty-three bridges over the river at points where no river crossings now exist. The first bridge is scheduled to be built at LaSalle St. in 1926, at Congress St. in 1927 and at Wabash Ave. in 1929. Others are of later date. The Wabash and LaSalle St. bridges will provide north side links to the South Water St. double-deck improvement well under way. None of the twenty-three can be planned until the city council decides the question of whether the river is to be crossed by fixed or movable spans.

The extension bridge is looked upon favorably by the South Park and Lincoln Park Boards and has a much better chance of early construction than the outer park drive on the breakwater accepted several years ago by the city, parks and Illinois Central R.R., because federal and state authorities will not grant permits for the outer crossing until proper harbor facilities have been assured. The present site is midway between the double-deck Michigan Ave. bridge and the original outer drive on the breakwater.

Opportunities Are Offered Contractors in Cuba

All work to be undertaken under the Cuban public works law is open to all contractors, native or foreign, according to Ambassador Enoch H. Crowder, of Havana. Bids and specifications must be submitted, and the regular system provided for the awarding of all these public contracts will govern the contracts under this law. The most important of these works, such as the central highway, which will run through the six provinces, construction of aqueducts for those cities which have none, schoolhouses, and sewerage in some of the larger cities, will be undertaken so as to be finished within four years.

All contractors must submit their differences for settlement to the courts of Cuba, without in any case alleging that they are foreigners, if such, and without making any claims before the Cuban Government other than through its courts.

In order to obtain a contract under this law, construction enterprises must present sealed bids. The award will be made to the responsible bona fide bidder whose proposition as to prices, materials, services, and time of execution is most advantageous to the state, except when the awarding official elects to exercise the right to reject all proposals for reasons which under the law governing these matters allow him so to do. The government, on the other hand, is protected from default on the part of the contractor by making him furnish a bond for faithful performance of his contract.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Montreal, Que., Canada, Oct. 14-16, 1925.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Convention, St. Louis, Mo., Oct. 19-22, 1925.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION, Chicago, Ill.; Annual Convention, Buffalo, N. Y., Oct. 20-22, 1925.

ASPHALT ASSOCIATION, New York City; Annual Paving Conference, Detroit, Mich., Oct. 21-23, 1925.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Lakeland, Fla.; Annual Meeting, Des Moines, Iowa, Oct. 26-30, 1925.

CITY MANAGERS ASSOCIATION, Lawrence, Kansas; Annual Convention, Grand Rapids, Mich., Nov. 17-19, 1925.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Detroit, Mich., Nov. 18-20, 1925.

HIGHWAY RESEARCH BOARD, Washington, D. C., Annual Meeting of the Highway Research Board, Washington, D. C., Dec. 3-4, 1925.

The American Welding Society will hold its annual fall meeting at the Massachusetts Institute of Technology at Cambridge, Mass., on Oct. 21-23.

County Engineers of Washington, at their annual meeting held in Spokane, Wash., elected the following officers for the ensuing year: L. R. Sampson, of Whitman, president; O. E. Brasnears, of Yakima, vice-president; and E. A. Middlebrooks, of Cowlitz, secretary. The engineers adopted a resolution favoring the appointment rather than election of county engineers.

The American Association of Port Authorities at its fourteenth annual convention held in New York City, Sept. 28 to Oct. 1, elected the following officers for the ensuing year: President, J. Spencer Smith, New York City; vice-presidents, G. B. Hegardt, Portland, Ore.; Brig. Gen. T. L. Tremblay, Quebec, Canada, and W. F. Williams, Boston, Mass. Tiley S. McChesney, New Orleans, La., is secretary.

Personal Notes

F. B. TOUGH, director of the leasing division of the U. S. Geological Survey, has resigned to become engineer in charge of production for the Humphreys Oil Corporation. With the retirement of Mr. Tough, the position he has occupied will be abolished and three field divisions are to be established as noted under the Washington notes in this issue. These divisions will be in charge of R. C. PATTERSON at Taft, Calif., J. W. STEELE at Casper, Wyo., and H. J. LOWE at Muskogee, Okla.

M. C. HINDERLIDER, who has held the position of state engineer for Colorado during the past two years as a provisional appointee pending a civil service examination, stood at the head of the list of those taking the civil service examination and, therefore, became entitled to the regular appointment.

LARS LANGLOE, reclamation engineer in the state department of conservation and development at Olympia, Wash., has resigned, his resignation effective October 15. The duties of the office will be taken over temporarily by R. K. TIFFANY, supervisor of hydraulics. Mr. Langloe has been with the department since 1921. He will assume charge of reclamation development for the Riverview Farm Corporation of Seattle on Blalock Island in the Columbia River, near Patterson, Benton County, the project embracing 2,500 acres.

H. S. GRASSMAN, who was recently connected with the Foundation Company at Mishawaka, Ind., has entered the employ of the Department of Water Supply of the City of Detroit as designing engineer on tunnels.

CHARLES H. PIERCE, New England district engineer water resources division, U. S. Geological Survey, Boston, has resigned effective Nov. 1 to join the staff of Charles T. Main, mill architect and engineer, Boston.

Obituary

EDWARD HUNT DAVIS, engineer for the third division of the State Highway Department of Georgia, died suddenly at his home in Griffin, Ga., Sept. 16. Mr. Davis was a graduate of the Georgia School of Technology in the class of 1887.

G. A. WADSWORTH, superintendent of the Evanston (Ill.) water works, was electrocuted Oct. 1 while making repairs to the motor of a sump pump in the pipe gallery of the filtration plant. He was 62 years old and had been in the employ of the Evanston water department for 31 years, starting as assistant to the engineer at the pumping station. Mr. Wadsworth had sent his men out of the gallery and was found about an hour later, his body having fallen into the water of the sump but with his head above water. An electrical burn on the neck and a deep scalp wound and position of the body indicated that he must have been standing on a wet valve and received the full force of the 220-volt current. He was a member of the American Water Works Association and took a lively interest in the affairs of the Illinois Section.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Ask That No Sales Meetings Be Held During Road Show

At a recent meeting of the executive committee of the Associated Equipment Distributors, also attended by directors of the Highway Industries Exhibitors Association, it was decided to ask that the manufacturers hold no sales meetings during the period of the coming National Good Roads Show, in Chicago, Jan. 12-15.

The Associated Equipment Distributors have agreed to co-operate with the manufacturers, on the understanding that no sales meetings would be held on the Road Show dates named, by changing the annual meeting of the Equipment Distributors from Jan. 8 and 9 to Jan. 5 and 6. Manufacturers in the Wisconsin territory are requested to hold their sales meetings on Thursday and Friday preceding the Road Show, and the others are asked to hold theirs in Chicago on Saturday, Sunday and Monday preceding the Show; it is also requested that all meetings be limited to one-half day.

It is pointed out that the Road Show is designed as a place for the exhibition of new machinery to the buying public. The opportunity has been taken for meetings of distributors and dealers until the time of these interests, as well as that of the manufacturers, is seriously over-crowded.

President C. R. Ege and the directors of the Highway Industries Exhibitors Association state that they pass this suggestion on to all members with the request that it be observed.

Crushed Stone Association to Have an Engineering Bureau

The National Crushed Stone Association has just announced an extension of its activities by which there is established in Washington, D. C., a bureau of engineering. At the same time, the secretary's office, which had been previously located in Columbus, is to be moved to the main office in Washington. As noted on p. 609 of this issue, A. T. Goldbeck, recently chief, Division of Tests, United States Bureau of Public Roads, will act as director of the engineering bureau. The association announces that the new activities have been undertaken to extend the knowledge of crushed stone through field and laboratory tests to determine what characteristics of the material require further investigation, to stimulate the testing of these aggregates by other laboratories, to interpret the results of researches on aggregates, to assist as far as possible state and municipal highway departments in their problems regarding aggregates, to represent the interests of crushed stone on technical committees writing specifications for aggregates, and generally to study the uses of aggregates for all forms of construction.

Business Notes

THE RUSSELL & CO., Massillon, Ohio, announces the appointment of the Utility Equipment Co., Union Building, Pittsburgh, Pa., as its agent in the Pittsburgh district and central Pennsylvania.

EQUIPMENT CORPORATION OF AMERICA announces that Tom Davis has been transferred from Chicago and is now in charge of its Pittsburgh district. Mr. Davis joined the Chicago sales force when his company, the Great Lakes Equipment Co., was absorbed about two years ago.

PARADON ENGINEERING CO., Long Island City, N. Y., announces that its southwest district office formerly located at Oklahoma City has been moved to Atlas Building, Tulsa, Okla. Lawrence K. Cecil still retains charge of the sales and service in the southwest.

BRADLEE VAN BRUNT has resigned as manager of publicity for the Bucyrus Co., South Milwaukee, Wis., manufacturer of power shovels and dredging equipment.

B. E. LINDSTROM has been appointed head of the Chicago office of Barber-Greene Company, Aurora, Ill., to fill the position made vacant by the death on June 26 of Mr. George R. Bascom.

R. D. WOOD & CO., 400 Chestnut St., Philadelphia, Pa., has announced that it will construct at Florence, N. J., a plant with a capacity of about 400 tons of centrifugal cast iron pipe per day to be manufactured by the "Sand Spun" process.

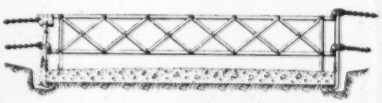
Equipment and Materials

Asphaltic Material Applied Cold Without Aid of Solvents

A development that permits an asphalt of known properties and of known quality to be deposited on steel, concrete, wood or other structural surface without the aid of heat or of asphalt solvents consists of a means of breaking up an asphalt into minute particles in the presence of water, the particles being held in suspension indefinitely. The resulting material is known as Hydralt, and is manufactured by J. W. Gardner, Inc., N. Y. The water facilitates spreading the material and later evaporates, permitting the asphalt particles to flow together, forming a continuous asphalt sheet over the surface. The chief advantage claimed for the material is that the asphalt is of known qualities whereas cold applications made possible by the use of solvents are often completely altered from their original and determinable state. Since the sheet of asphalt as applied contains no volatile oils, it will not become brittle and will not crack, flake or peel. Hydralt is applied as a soft semi-fluid paste with either a brush or a spray. Its covering capacity is about 80 sq.ft. per gal. per coat.

Road Barricade for Use on Highway Construction

Barricades of various kinds are being constantly used by contractors to divert traffic around construction operations and freshly laid pavement. Since many of these are of such a construction as to be ineffective to protect the road against any determined effort on the



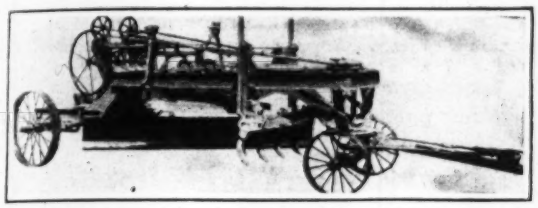
part of intruders, the Blaw-Knox Co., Pittsburgh, Pa., has added to its line of products a steel barricade that has been invented by R. A. Trufant, a highway engineer in the State of Illinois. The barricade is made from riveted steel shapes and includes two standards and a gate. The standards grip the sides of the pavement slab as shown in the illustration and the barricade cannot be disturbed until unlocked. Side chains to prevent ingress around the sides of the barricade may be added if desired.

Road Grader Uses Scarifier Tooth of New Design

A new scarifier tooth designed like a rooter plow to dig in and hold its position under a hard crust, without the excessive weight of a heavy block, is an outstanding advantage of the Gradefier, a combination grader and scarifier, recently developed for road work by the Stockland Road Machinery Co., Minneapolis. It is claimed that by adapting the rooter plow design to the scarifier tooth, a suction action is obtained which not only forces the tooth under the road surface and keeps it in place there but also holds the grader rigid with no tendency toward elevating the front wheels. The scarifier block on the machine is operated independently of the blade and weighs approximately 800 pounds. It is of cast steel with detachable teeth equipped with replaceable tips of chrome molybdenum to withstand abrasion. The drawbars are 1¼x5 inch high carbon steel and are attached to the front bench by a cast steel nose. The block is held rigid against side thrust

by two braces riveted to the draft bars and attached to the nose; also the pitch of the block can be changed for different types of work.

To meet the demand for fast easy operation of the grader blade behind the scarifier block, an auxiliary spring lift is connected by chain over a pulley to a lever arm on the blade circle assembly. The auxiliary lift equipment



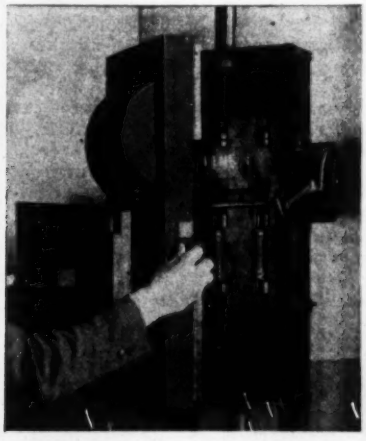
practically allows the operator to spin the handwheels in lifting the blade. The blade is suspended by means of a straight bar across the extreme rear of the circle, a departure from the old type of draw bar angles ordinarily bolted to the draft bar angles bolted in turn to the circle. This change eliminates loose play and provides more rigid construction for the circle suspension.

The steering device is an improved combination of the former built-in and pole device. Bevel gears at the top and bottom of the king-bolt plus worm gears and wheel out on the pole permit turning of the front wheels by the handwheel even when the pole is on the ground. Other mechanical details are: wheel base 16½ ft.; blade length, 10 or 12 ft., width, 17 in.; blade lift, 14 in. from ground; lateral shift of blade, 30 in.; lateral shift of rear axle, 48 in.; pivotal shift of rear axle, 18 deg.

New Safety Switch Design Protects Operator

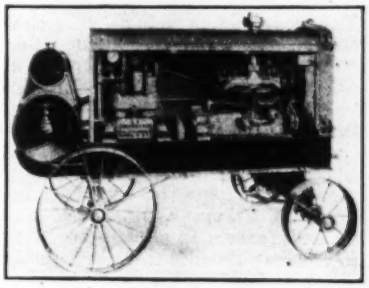
A new safety switch known as WK-55 has been introduced by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., the design of which provides full safety for the operator and the motor under all conditions. In order to eliminate the possibility of the operator coming in contact with live parts, the switch has been designed with a double door construction. Within the main door of the switch is a smaller door giving access to the fuse compartment. This fuse compartment door is interlocked with the operating handle in such a way that it will not open until the switch is thrown to the off position. In this position, even with the door open, no live parts are accessible and as long as the door remains open the switch cannot be thrown on. The outer door covering the entire switch inclosure is designed for padlocking. This outer door can be opened for inspection and testing without interrupting the service.

The new design removes the danger of loose parts coming into contact with current-carrying parts of the switch which would cause dangerous short-circuit hazards. There is ample space for all wiring. An arc quencher of simple design serves to extinguish the arc quickly and efficiently when the circuit is open.



Portable Compressors Have Electric Welded Frames

A new series of three portable air compressors of 118, 160 and 260 cu.ft. of free air per min. capacity is being manufactured by the O. K. Clutch & Machinery Co., Columbia, Pa. The units are all of the same type differing only in size. The frames are of structural steel channels fabricated by



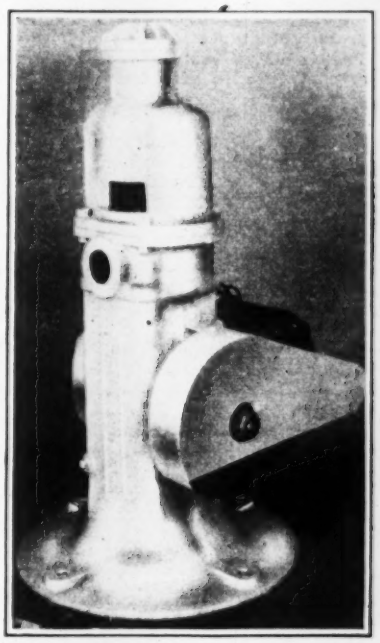
electric arc welding. The radiators are of special design and are claimed to be unbreakable from any freezing action. The engine is a four cylinder four-cycle design direct connected to the compressor by a special clutch and coupling.

The compressor is of heavy construction extra thick cylinder walls being provided for re-boring purposes. The cylinders are completely surrounded by a water jacket and all adjustable parts are easily accessible. Valves are removed by taking off bolted caps instead of the whole cylinder head, and large hand holes are provided on each side of the crank case. Pistons, connecting rods and crankshaft are made of chrome vanadium steel.

The units are mounted on a truck with steel tired wheels and are completely enclosed in steel housings. The weights are 3,200, 4,500, and 6,000-lb. respectively. Rubber tired wheels can be furnished if desired.

Power Head Totally Inclosed on Deep Well Pump

A new line of deep well pumps recommended for heads up to 600 ft. and able to discharge about 260 g.p.m., having their power heads completely inclosed, is manufactured by the Amer-



ican Well Works, Aurora, Ill. The main frame totally surrounds all the gears and all of the main bearings and gears run in a bath of oil, a feature which is claimed to make the operation of the pump practically noiseless. These heads are made for both 6- and 12-in. strokes for operation with single stroke cylinders. The displacement cylinder is the same diameter as the lower cylinder, which permits the removal of the plunger rod and plunger without breaking either the suction or discharge connection. The equipment is furnished either with a drive pulley for motor drive or a tight and loose pulley for gasoline engine operation. The T-head at the bottom is tapped for a maximum size drop pipe of 4½ in. and a maximum discharge pipe of 2½ in. The horsepower varies from ¾ to 5, depending upon the head and required discharge.

Publications from the Construction Industry

Gypsum Floors and Ceilings—STRUCTURAL GYPSUM CORP., Akron, N. Y., has made available a 55-page booklet describing its system of precast reinforced gypsum slab construction for floors and ceilings. In addition to a description of the methods used in construction, specifications and blueprint-details are given for typical installations. A section of the booklet is also devoted to poured-in-place floors and roofs. A list of installations in

some buildings using this type of construction is also given.

Building Tile—THE CLAY PRODUCTS Co., Brazil, Ind., has made available a folder containing sheets of design details of its standard units and shapes of Insul Glaz tile and Caentile and some of their uses in wall construction. Complete descriptions are given of the two different types of tile and results of tests made on this tile at the university of Wisconsin are reproduced.

Crawler Tractors — CATERPILLAR TRACTOR Co., San Leandro, Calif., has issued a pamphlet describing its new line of tractors, consisting of five models, upon each of which detail catalogs are available.

Chlorinators—WALLACE & TIERNAN, Newark, N. J., has recently published Bulletin No. 55 describing its chloromcter which finds application in the sanitation of swimming pools and the purification of small water supplies.

Cement-Lined C. I. Pipe—AMERICAN CAST IRON PIPE Co., Birmingham, Ala., is distributing a booklet describing cement-lined cast-iron pipe. In addition to descriptive matter and illustrations of manufacturing methods, there are two reports on the use of cement-lined cast-iron pipe. The first of these, by J. E. Gibson, manager, water department, Charleston, S. C., is entitled "Determinations of the Coefficient C in Hazen's and Williams' Formula for Cement-Lined Cast-Iron Pipe." The second report is on "Some Aspects of Tuberculation and Red-Water Troubles," by H. Y. Carson, research engineer, American Cast Iron Pipe Co.

Timber Construction — NATIONAL LUMBER MANUFACTURERS ASSOCIATION, Washington, D. C., states that the object of its new publication, "Details of Heavy Timber Mill Construction," is to put into the hands of designers and draftsmen the most up-to-date information on good practice in timber detailing. The bulletin represents the latest chapter of the construction information series, "Lumber and Its Utilization" and contains six line cut detail drawings of standard mill construction.

Compressors and Trench Pumps — DOMESTIC ENGINE & PUMP Co., Shippensburg, Pa., has recently issued two new catalogs. Catalog 25-A describes the company's portable air compressor unit giving size recommended for different installations and various pneumatic tool data. Bulletin 25-T describes the company's trench pump unit.

Roller and Ball Bearings — NORMA-HOFFMAN BEARINGS CORP., Stamford, Conn., has recently issued two new bulletins. The first on ball bearings of both the open and closed type describes the methods used in manufacture and gives tables, showing sizes, dimensions, and load ratings for the different types. The second booklet is on roller bearings, and in addition to describing the manufacturing methods gives notes on lubrication and protection of the bearings.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks.

Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings.

Money Value of Contracts Let—Entire U. S.

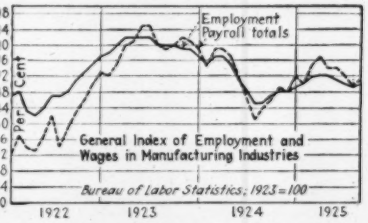
Week Ending	Public Work	Private Work	Total Contracts
October 8, 1925	$29,372,000	$31,107,000	$60,479,000
October 1, 1925	20,212,000	64,592,000	84,804,000
October 9, 1924	15,048,000	26,481,000	41,529,000
Heaviest Week			
1925, Sept. 3	16,215,000	69,424,000	85,639,000
1924, May 8	26,370,000	38,829,000	65,199,000
January 1 to Date			
1925	852,688,000	1,147,225,000	1,999,913,000
1924	798,178,000	809,969,000	1,608,147,000

Prices of Materials and Labor Higher—Gain In Factory Employment and Pay-Rolls

Labor Supply in Excess of Demand in Only Nine Out of Forty-eight States—Record August and September Construction Volume

With construction volume at record levels and practically all building trade mechanics busily engaged, attention is drawn to employment conditions in other industries.

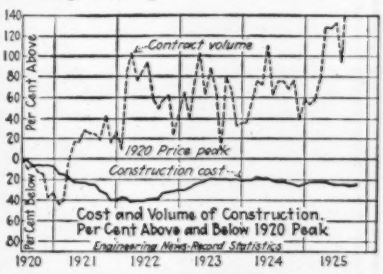
The only states in the nation where the employment situation is not favorable to those seeking work, are Maine, New Hampshire, Vermont, Indiana, Ohio, Arkansas, Oklahoma, Alabama and Texas. In all other sections of the country conditions if not actually good are at least fair.



The Bureau of Labor Statistics, in its latest investigations, finds employment on the increase at mills and factories throughout the country, with commensurate gains in pay-roll totals. About the only industries reducing or attempting to cut wages are textiles and shoes and in one instance a steel and tin plate company.

The common laborers' wage rate has taken an unseasonal turn upward, according to *E. N.-R.* figures for the entire country; this is the natural result of the added mill activity.

Increased cost of labor and building materials is responsible for the rise of over one per cent in the October construction cost Index, compared with the month preceding.



The Bureau of Labor Statistics reports a rising trend in wholesale prices of farm products, foods, cloths, clothing, metals, metal products, building materials, chemicals, and drugs.

According to the National Industrial Conference Board, the upward trend in the cost of living has affected practically all the countries of the world during the past few months.

In the following tabulation the index numbers of wholesale prices are based on 1913 as 100:

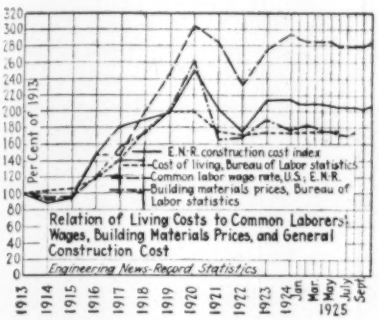
Year	U. S.	England	France	Canada	Japan
1919	211	219	...	198	241
1920	239	233	187	223	242
1921	149	156	133	150	175
1922	158	150	136	147	175
1923	164	159	124	147	183
1924	159	160	121	145	166
1925*	165	170	124	152	162

* First six months.

Index numbers showing rent costs in five countries, as compared with 100 for 1913, are as follows:

Year	U. S.	England	France	Canada	Italy
1920...	151	118	100	134	108
1921...	161	145	110	144	139
1922...	161	153	164	146	202
1923...	164	148	200	147	234
1924...	168	147	200	146	329
1925*..	...	147	200	145	392

* First four months.


Per Cent of 1913
E.N.R. construction cost index
Cost of living, Bureau of Labor statistics
Common labor wage rate, U.S., E.N.R.
Building materials prices, Bureau of Labor statistics
Relation of Living Costs to Common Laborers' Wages, Building Materials Prices, and General Construction Cost
Engineering News-Record Statistics
1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 Jan Mar May July Sept 1925

New Price Basis Adopted for Linseed Oil

The practice of quoting linseed oil prices by the pound instead of by the gallon, as formerly, has been officially adopted by the National Lead Company.

In a letter to its customers, the Lead Company emphasizes the economic soundness of the new method.

The reason for the change is given as follows:

"The pound basis is being adopted to do away with the inaccuracy of the gallon unit. The 7½-pound gallon as a measure for linseed oil is at best a makeshift. It varies in volume. It is confusing. It is not in accord with the practice followed in selling other vegetable oils. It is unsound economically.

"The manufacturer has been selling linseed oil by weight—7½ pounds to the gallon. The dealer who buys this linseed oil by weight on the other hand, sells it by the gallon. A measured gallon of linseed oil has no fixed weight. It weighs more or less than 7½ pounds depending upon temperature. Usually it weighs more. The result is that the dealer who measures his oil, instead of weighing it, loses perhaps ¼ pound every time a gallon is sold.

"A pound of linseed oil, however, is always a pound. It is a pound when it leaves the manufacturer. It is still a pound when the dealer gets it and when he sells it.

"In changing to the pound basis in quoting linseed oil, we believe that we are taking a step which will benefit and which will be welcomed by all in the trade. The principle is sound. The new price basis will work for the good of all—the manufacturer, the jobber, the dealer, the consumer."

A card is issued, showing various prices per pound and what oil at these prices figures per 7½-pound gallon. With the aid of the card it is possible to tell what linseed oil, quoted at a certain price per pound, is equal to on the old 7½-pound gallon basis.

Bond Sales for Municipal Improvement Near Record Total In September

State and municipal bond sales during the first nine months of the present year, amount to more than a billion dollars, according to the *Daily Bond Buyer* of New York. During the month of September placings of new issues amounted to $108,783,649 compared with $92,560,822 for the corresponding month of last year. The total for the year to date is given as $1,046,570,409 or about $110,000,000 less than the total for the same period a year ago.

Among the important issues placed in September were $15,000,000 4½s by the city of Philadelphia; $10,000,000 4s, State of Illinois and $10,000,000 4s, State of Pennsylvania.

During the past ten years, the September, 1925 public bond sales have been surpassed on only one occasion and that was in the total for September, 1922.

The accompanying table was drawn from the bond proposals and negotiations published in the *Commercial and Financial Chronicle* during the past month. The rates range from 4 to 6 per cent. Most of the issues commanded a premium, while a few were placed at or below par.

Representative Public Bond Sales, September, 1925

State	Purpose	Amount	Rate per Cent	Sold For	Basis	Dated	Maturity	Purchased By
Illinois	Highway	$10,000,000	4	96.422	4.24	Mar. 1	1945-54	First National Bank of N. Y. and others
Missouri	Road	7,500,000	4½	99.81	4.28	Mar. 1	1939-42	National City Co. and others
Oregon	Highway	2,000,000	4½	100.005	4.40	Oct. 1	1931-50	Detroit Co. and others
Pennsylvania	Highway	19,449,000	4	100	4	.....	1941-53	National City Bank of N. Y. and others
County								
Allegheny, Pa.	Road	1,585,000						
	Bridge	460,000						
	Court house ext.	300,000	4	100	4	Aug. 1	1926-55	Union Trust Co. of Pittsburgh
	Juvenile home	75,000						
Alcorn, Miss.	Road	150,000	5	100.90	.....	.....	.....	Wm. R. Compton Co. of St. Louis
Buchanan, Va.	Road	40,000	5½	.....	.....	Aug. 1	.....	Seasongood & Mayer, Cincinnati
Benton, Ore.	Road	200,000	4½	100.018	4.67	Sept. 1	1931-45	Ralph Schneelock Co. of Portland
Cache, Utah	School	100,000	4½	100.62	.....	.....	11-20 yrs.	The Central Trust Co. of Salt Lake City
Cameron, Tex.	Flood control	1,500,000	4½	100.007	4.83	Sept. 1	1926-65	H. C. Burt & Co. of Dallas and others
Clinton, N. Y.	Highway	48,000	5	109.45	4.23	Aug. 1	1939-47	Geo. B. Gibbons & Co., Inc., of N. Y. and others
	Buildings	70,000						
Coos, Ore.	Road	380,000	4½	100.26	4.72	Sept. 1	1930-39	Wells-Dickey Co. of Minneapolis and others
Curry, Ore.	Road	23,000	5	100.51	4.95	Aug. 1	1930-39	Blythe, Witter & Co. of Portland
Cass, Ind.	Road	50,300	5	103.30	4.30	Sept. 15	1926-35	Meyer-Kiser Bank of Indianapolis
Colusa, Calif.	Reclamation	2,620,000	6	101.50	5.84	.....	1934-42	C. R. Ross and others
Camden, N. C.	School building	20,000	5½	101.32	5.36	July 1	1928-47	Braun, Bosworth & Co. of Toledo
Dublin, N. C.	Road	520,000	5	.....	.....	Sept. 1	1935-45	Braun, Bosworth & Co. of Toledo
Duval, Fla.	Road	1,500,000	5	103.82	4.76	Oct. 1	1955	Harris, Forbes & Co. of N. Y.
Elkhart, Ind.	Road	52,900	4½	102.13	4.245	July 15	1926-45	Fletcher-American Co. of Indianapolis
Howard, Ind.	Road	26,584	4½	101.01	4.29	Sept. 15	1926-35	Fletcher-American Co. of Indianapolis
Muscatine, Ia.	Road	30,000	4½	100.01	.....	.....	.....	First National Bank of Muscatine
Ottawa, O.	Highway	19,000	5	100.79	4.805	Sept. 21	1926-34	Breed, Elliott & Harrison of Cincinnati
Schuylkill, Pa.	Highway and bridge	400,000	4½	100.646	4.18	Aug. 1	1955	Strand & Co. of Philadelphia
Stanley, N. C.	Road and bridge	100,000	5	103.53	4.72	May 1	1945	R. S. Dickson & Co. of Gastonia and others
Township								
Annville, Pa.	Road impvt.	36,000	4½	102.867	4.20	June 1	1930-43	Annville National Bank
Beccaria, Pa.	Improvement	35,000	4½	100.25	4.44	May 1	30 yrs.	First National Bank of Coalport
Steubenville, O.	Road impvt.	12,017	5	100.05	4.99	Sept. 1	1927-34	A. E. Aub of Cincinnati
Municipal								
Akron, O.	Street impvt.	1,139,100	5	101.51	4.70	Oct. 1	1927-35	Halsey, Stuart & Co. of Chicago and others
Barbertown, O.	Storm sewer	20,721	5	100.89	4.785	Aug. 1	1926-34	W. L. Slayton & Co. of Toledo
Bartow, Fla.	Light and power	120,000	5½	100.86	5.18	July 1	1931-55	Vandersall & Co. of Toledo
Bloomfield, Neb.	Light and power	50,000	5	.....	.....	Aug. 1	20 yrs.	Nebraska State Bank of Bloomfield
Brazil, Ind.	Park improvement	4,882	4½	100.58	4.29	Aug. 14	1926-35	Fletcher-American Co. of Indianapolis
Canton, O.	Street improvement	68,911	5-5½	101.93	4.86	Sept. 1	1927-30	Stranahan, Harris & Oatis, Inc., of Toledo
Conetoe, N. C.	Light and power	10,000	6	100	6	Jan. 1	1927-46	Earnest L. Dawson
Crookston, Minn.	Paving	34,150	4½	.....	.....	.....	1-10 yrs.	Minneapolis Trust Co.
Dayton, O.	Waterworks	500,000	4½	100.23	4.475	Sept. 1	1926-50	Eldredge & Co. of New York
	Storm sewers	200,000						
Dundee, Fla.	Waterworks	25,000	6	99.25	6.09	July 1	1929-53	Stranahan, Harris & Oatis, Inc., of Toledo
Leesburg, Fla.	Improvement	265,000	6	104.60	.....	July 1	5-30 yrs.	Braun, Bosworth & Co. of Toledo
Massillon, O.	Storm sewer	75,000	5	103.13	4.635	Oct. 1	1927-45	N. S. Hill & Co. of Cincinnati
Perth Amboy, N. J.	School	32,000	4½	101.27	4.645	Oct. 1	1927-55	R. M. Grant & Co., Inc., of N. Y.
	Water	60,000		101.12	4.65			
	General improvement	141,000		100.27	4.70			
Philadelphia, Pa.	.....	15,000,000	4½	100.301	4.23	Sept. 16	1975	National City Co. and others
Port Chester, N. Y.	Paving	880,000	4½	100.247	4.45	Oct. 1	1926-31	Roosevelt & Son of N. Y. and others
Texarkana, Tex.	Street improvement	200,000	4½	97.75	4.93	Sept. 1	1936-65	H. C. Burt & Co. of Austin

Weekly Construction Market

CONSTRUCTION cost is but one per cent below its level of a year ago. The gradual downward tendency has been in evidence since March, 1924. This direction may be followed for some time to come, perhaps years, but records show that the low point of each temporary depression is usually higher than that of the one preceding it.

When the general trend of construction cost is considered, the fact that the movement has been decidedly upward during the past twelve years and also that wholesale prices of all commodities have been gradually climbing higher since 1890, does not support a belief that permanently lower markets are in sight.

While the gain in volume of construction and of business generally has been abrupt during the present quarter, the slow movement of prices and the lack of violent fluctuations has given the situation more of an appearance of stability.

In the current market for basic building materials there is notable firmness with tendency to rise in reinforcing bars, lime, sand, pine and fir timbers, shingles, white oak and yellow pine flooring, and turpentine. The declines, few in number, appear in steel plates, common brick, and plate glass. Little tendency to change is shown in prices of cement, gravel, nails, hemlock timbers, window glass, putty, and white lead.

Favorable crop reports from the South and West are resulting in an increasing volume of Autumn trade. The Florida real estate boom in the South and increased logging and lumbering activities in the Northwest serve to offset some of the depressing influences of the strike in the anthracite mine area.

The iron market, always barometrical of general conditions, is summarized as follows: Iron prices tending upward; demand steady; reserves stocks diminishing; No. 2 fdry. So., up 50c. per ton during the week.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.90	$4.00	$3.10	$3.35	$3.07½	$3.30	$3.35	$4.25
Structural rivets, 100 lb.	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.40	2.80	3.00	3.25	+3.77½	3.35	3.25	2.30
Steel pipe, black, 3½ to 6 in. lap, discount	48%	+54%	53.6%	51%	54.25%	36%	39.2@51%	50%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@51.60	+46.40	54.00	49.20@50.20	53.00	63.00	54.00	+55.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.25	2.05	2.20	2.42	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd.	1.75	2.20	2.38	2.00@2.20	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd.	1.00	1.65	2.00	2.00@2.20	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.20	2.83	2.00@2.20	1.75	2.50	2.15	3.00	1.90
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	+61.00	34.00	58.50	+53.50	—36.75	33.75	27.00	+25.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	18.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.25@2.75	1.30	1.85	—1.30	1.35	2.70	1.60	2.80	9.50
Common brick, delivered, 1,000	17.50@18.00	10.50	11.60	12.00	13.50	12.00	15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0893	.10	.075	.....	.085	....	.10	.12
Hollow partition tile 4x12x12, per block	—.1027	.0893	.10	.075	.07	.085	.108	.10	.10
Linseed oil, raw, 5 bbl. lots, gal.	—1.04¼	—1.09½	1.13	1.05	—1.11	1.27	1.15	1.12	1.25
Common Labor									
Common labor, union, hour	.55@.75	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.82½	— 45@.55	35@.50	.50	.50	.25@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 55c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job; pine is 4-in. instead of 3-in.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of October 1, the next on November 5.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per to., instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stand at 100.03). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Business Briefs

Call money quoted at 5@5½ per cent, Oct. 5; year ago, 3 per cent.

Time loans: short periods, 4½@4¾ per cent; longer terms, 4¾@5 per cent.

Commercial paper: best names, 4½ per cent; other names, 4¾ per cent.

On October 1, 1925

E. N.-R. Construction Cost Index Number 205.35

E. N.-R. Construction Volume Index Number 262

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month